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CONTENTS

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The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it. Editorials are by the Editor-in-Chief unless otherwise indicated and do not necessarily represent the opinion of the Society as a whole. The "leaders" preceding major articles are to be regarded as editorial additions.

EDITORIAL

Where Is the Money Coming From?

IS forestry in the United States on the dole? If so, how long does the profession plan to let such a condition continue? Are we foresters, as considered by the layman, principally spenders of public moneys, rather than the trustees of other people's capital and producers of forest wealth and benefits? These are questions which Mr. John Taxpayer is asking today and which he may choose to answer for himself, and in his own way, in the near future.

There has appeared recently among certain forward-looking foresters an undercurrent of dissatisfaction with the alleged lack of positive leadership within the profession along progressive lines. By this may be meant that type of leadership which will have the initiative to assume the responsibility for the growth and justification of the forestry movement economically.

The conservation movement was born during a period of political leadership. It gave to public forestry in its youth an impetus that has enabled it to carry on with steadily decreasing momentum, very nearly up to the present. By what might almost be termed "an act of God," another Roosevelt, another ardent conservationist, has attained the Nation's highest position and public forestry is experiencing a renaissance which will last as long as large federal appropriations are available, that is, as long as the taxpayer from his surplus earnings will be able and willing to pay into the federal treasury the required funds. The government can, of course, print the dollar bills, but they will have no value unless adequately backed by the wealth or profits created by the taxpayers' constructive effort. The government might borrow the money, but its citizens can loan it only after they have first earned it by productive enterprises. They will loan it only if they are sure the government will use it in enterprises that in themselves are productive.

Now this is no criticism of such a method for raising working capital to protect, administer and profitably work the publicly owned forests; nor is it an adverse criticism of the use of public funds to help in the solution of an acute social problem during the national crisis. It is instead an emphasis that in helping to clear up such situations a new one is being created. It does seem as if the typical forester might concern himself with the people's real problem, namely, "Where is the money coming from?" He has been given an education, very often at the expense of the public, he is dealing with publicly owned forest lands bought with the public's money and is using working capital taxed from the

people. Surely he should not satisfy himself simply with deciding that a certain sum of money is necessary to carry on this work, but should be willing to take the next step and consider how and to what extent the taxpayer can first create the amount which he proposes to use.

In the past this forestry idea sounded all right to the average layman living in a city, miles from the nearest patch of real woods, with government expenses comparatively low, with taxes only a minor drag on business and with comparative freedom from economic worry. When he read the propaganda in support of bigger and better national forests or the arguments in favor of more intensive and more expensive forest research, his natural more or less absent minded reaction was, "These are fine things to do and they should be done; the government is rich and can afford such luxuries and they cost me nothing anyhow." Today this same average citizen is hemmed in on all sides by low profits if any, increasing labor expenses, greatly increased costs of being permitted to do business by the government, pressure from above against high selling prices, as well as a public without buying power. Last March when he made out his federal income tax return, he too often discovered that his income of the previous year, the earnings from his business, or the salary paid him by his employer, had shrunk ten—twenty—or sometimes over fifty per cent. In spite of that, his calculations told him that he must pay his government in the form of a federal income tax two to three times as much as had been required of him the year before. Next March when he is forced to repeat the painful process, he is too apt to find an even greater disparity, in spite of the repeal of Prohibition.

Naturally, Mr. John Taxpayer will ask and ask insistently, "Where is all this money going to that my government is taking away from me at a progressively increasing rate?" When he is told that it is needed in part to meet the cost of bigger and better national forests, of more intensive and more expensive forest research, or to continue and make permanent on an even larger scale, a forest-social experiment intended in the beginning to be only temporary, he will inevitably rouse himself out of his previous absent-mindedness, measure these public undertakings according to their direct value and benefit to him personally and in comparison with his own direct share of the cost. Maybe he will even go so far as to refuse to contribute his share until it has been proved to him more convincingly than heretofore that these public forest undertakings really and actually will return their cost in the form of direct profits to the man from whom the money must come.

Glittering generalities such as have been used in the past would hardly seem adequate for the purpose any longer. Mr. John Taxpayer, if he is old enough, will remember that back in 1905 a promise was made that the national forests would become self-supporting within ten (or was it five?) years and from then on would no longer be a burden on his shoulders. The income from the national forests since that time has been mounting steadily, at least until the present depression period. The cost of managing them, however, has been mounting at an even more rapid rate and the date when the books will balance is far more remote than it was 28 years ago. With such a precedent before his eyes, it will be far less easy to convince the taxpayer, the man from whom the money must come, that an increased program of forest research for which his money is needed, will return him dividends, or that the ECW undertaking, for the support of which is needed a large proportion of his shrinking income, will actually add to the material wealth of the country in a manner that will reimburse him for his share in it.

Does not all of this emphasize strongly that we foresters have a responsibility beyond that of merely spending the public's money and planning how much of the public's money we would like to spend? That we have an even greater responsibility of proving that the nice things in forestry which we would like to do with the other people's money, really are worth doing and that the other people who must furnish the money for us to spend really have it to furnish and can afford to furnish it. Is it not up to us to help answer the question, "Where is all this money coming from?"

HENRY M. MELONEY.

EDITORIAL NOTE: Henry M. Meloney, the author of this editorial, treats his subject from a broad background of experience and training that should render his views well worthy of consideration. He has been a member of the Society of American Foresters since 1924. He received his Bachelor's degree at the New York State College of Forestry in 1919, his Master's degree in forestry in 1922 and in 1924 earned some credits toward a Doctor's degree in economics at Columbia University. In 1919-20 he spent a year in Sweden as a travelling Fellow of the American-Scandinavian Foundation studying forest management and utilization. In 1930 he studied finance at Babson Institute, and insurance and finance at New York University in 1931.

In 1917 he served as Forest Guard, Timber Scaler and Forest Ranger in Arizona and New Mexico. During the war he was connected with the Spruce Production Division of the Air Service in Washington and Oregon. From 1920 to 1929 he was connected with the paper and lumber industries in selling and managerial capacities. He is Vice-President and Director of the Keystone Metal Tie Corporation, and during 1928 and 1929 he was specialist for the Bethlehem Steel Company in promoting the heavy Bethlehem-Keystone ties and also doing some forestry work. During the past four years he has been engaged in investment banking and insurance and has been particularly interested in the adaptability of insurance funds to forestry, business and individual needs.

ALLOCATING CUTTING BUDGETS BY MEANS OF A FOREST SKY LINE GRAPH

By A. E. WACKERMAN

Forester, Southern Forest Experiment Station

The author's method of allocating a cutting budget to the forest is graphic and easily understood. It is based on a chart of the forest inventory and growth by stands. The method was developed in the study of a private forest property as part of a project of the Southern Forest Experiment Station covering the financial aspects of private forestry.

THE problem of managing a forest property for sustained yield is, in most cases, intimately connected with that of furnishing some woodusing plant with a constant supply of raw material. Even when the production of forest raw material is the sole business of the owner, it is very desirable to have an even rather than a fluctuating income. When placing a forest property under management for sustained yield, therefore, it is necessary to balance the economic and silvicultural requirements of the property in planning the cutting budget.

For most private owners an income each year is essential, and silviculture is of secondary importance. In putting a forest under management, an annual cut, large enough to provide a reasonable annual income, must be determined upon, but at the same time the probable silvicultural condition of the residual stands that are to produce the next cut must be carefully considered.

From both operating and silvicultural standpoints it is desirable to do the required cutting first in the heaviest stands. Logging operations are more economical in heavy than in light stands, and the heavier the stand the larger the cut that can be removed per acre without too greatly depleting the growing stock. The plan of cutting the heaviest stands first is, of course, dependent upon the accessibility of all tracts and upon a method of logging, such as truck logging, under which tracts can be selected and logged in any desired order without seriously increasing the logging costs.

In planning sustained yield management for a small short-leaf-loblolly pine-hardwood forest property, all parts of which are accessible to truck logging, a graphic method was devised for balancing the economic and silvicultural requirements in allocating the cutting budget. The forest sky line graph, Figure 1, illustrates this method. It gives all the essential information needed for determining which areas should be cut in given years and how heavy a cut should be made.

The data from which the graph is constructed were obtained from a forest inventory survey and growth study, the results of which are shown in Table 1. Because the heaviest stands are to be cut first, the stands are listed in the table in descending order based on their present average volumes per acre. The estimated volume five years hence for each stand, if no cutting occurs, is also shown. Old-field stands are not shown in the table and are not included in the graph since they are different from and will be managed differently from forest-grown stands, and because they aggregate only a relatively small area.

The forest sky line graph, Figure 1, is largely self-explanatory. The curves of present volume per acre and volume 5 years hence are drawn for the purpose of averaging the inaccuracies of a 10 per

cent estimate and growth study by stands, and to facilitate the computations needed to determine the cutting budget. These computations would be laborious if each stand and its growth were to be considered individually. It should be noted in Figure 1 that the actual area on the graph occupied by any stand or group of stands represents the volume of the stand or group of stands. One inch on the vertical scale represents 1,000 board feet per acre and one inch horizontally 100 acres; one square inch, therefore, represents 100,000 board feet. Each stand is numbered at the base, and reference to an index gives the description.

In determining the cutting budget in this example, the principal economic consideration is that about 500,000 board feet must be cut each year to provide a satisfactory forest income. The chief silvicultural factor to be considered is that the stands after cutting must be capable of growing another cut by the time it is needed. This cutting budget problem was solved by plotting on the sky line graph various combinations of areas to be cut each year and amounts of timber per acre to be reserved, until one was found that would best meet the conditions.

The cutting budget illustrated in Figure 1 provides for the required output for the first five years and leaves the stands in such condition that the same cut could be maintained for another five years, after which the output could be materially increased. This was determined by constructing another sky line graph showing the forest inventory as it should be at the end of 1937, assuming that the trial cutting budget were adopted. Growth after cutting was estimated to be at the rate that stands with 3,500 feet per acre are now making, since this is the amount to be reserved per acre. Figure 1 shows the growth to be approximately 400 board feet per acre per year for such stands. Some stands with less than 3,500 feet per acre and not to be cut during the first five years, will have grown to 3,500 feet per acre or more at the end of that period. These stands (numbered 47 to 62) are included in the second cutting budget.

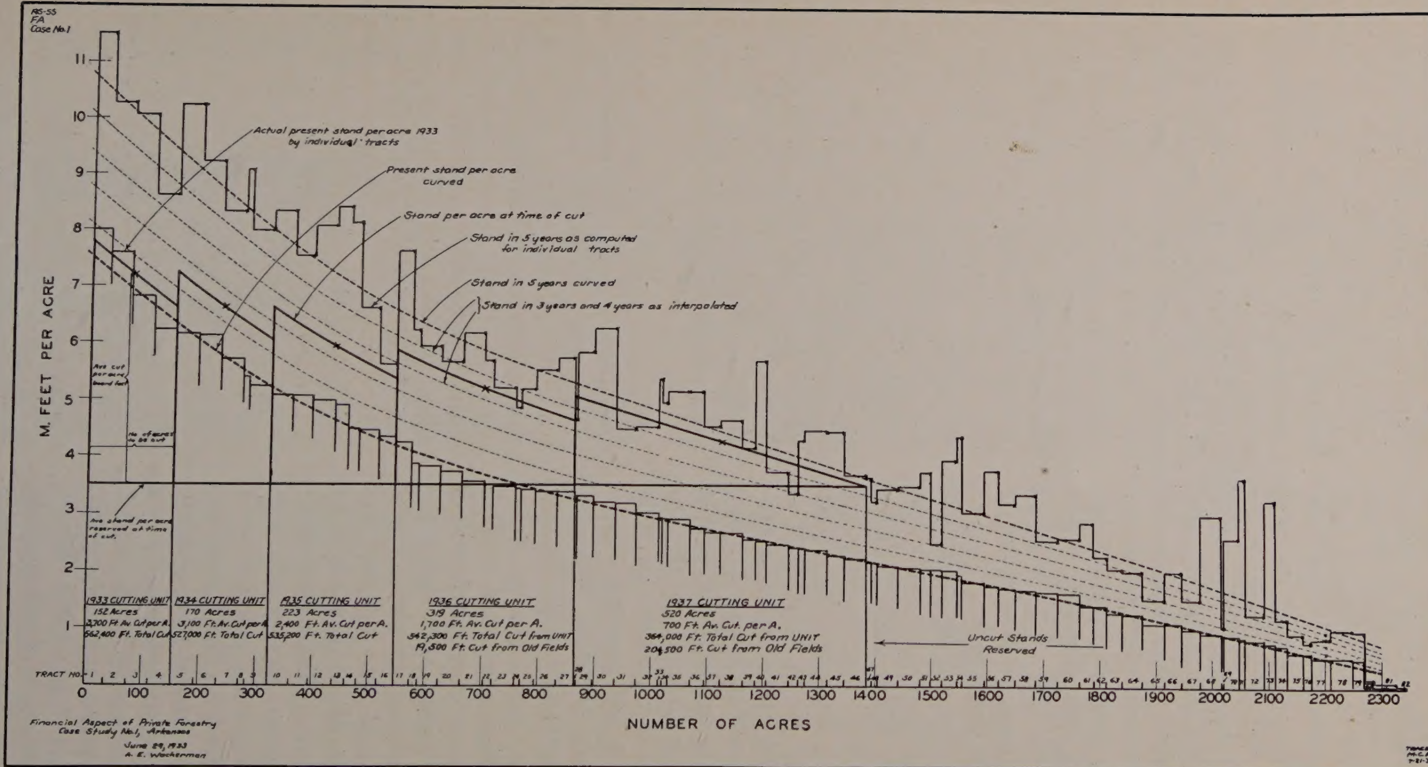
In Figure 1 the area to be cut in 1933 is 152 acres and the amount to be reserved is 3,500 feet per acre. The average stand per acre includes one-half a year's growth added to the curved present average volume per acre to provide for growth during the year of cutting. The total average stand per acre is 7,200 feet, as indicated by the small cross on the curve. The average cut per acre, then, is 3,700 feet, making a total of 562,400 feet to be cut from the 152 acres in 1933. This amount to be cut from the 1933 unit is represented on the sky line graph by the area enclosed between the two vertical lines limiting the number of acres; the lower line at 3,500 feet, which is the amount to be reserved per

TABLE 1

FOREST INVENTORY BY STANDS OF TIMBER 13 INCHES AND OVER D.B.H., BY VOLUME PER ACRE

Serial No.	No. of acres	Volume in 1933	Volume in 1937
		Bd. ft.	*Bd. ft.*
1	32	7,996	11,531
2	40	7,587	10,280
3	40	6,816	10,051
4	40	6,227	8,603
5	40	6,157	10,241
6	40	6,139	9,221
7	40	5,705	8,317
8	10	5,380	9,060
9	40	5,221	7,989
10	39	5,069	8,328
11	35	5,066	7,545
12	40	4,973	8,083
13	23	4,895	8,403
14	20	4,480	8,124
15	35	4,454	6,603
16	31	4,331	5,612

(Remainder of inventory listed in same way)



Individual tracts of forest grown stands arranged in descending order based on average stand per acre in board feet, with growth for 5-year period shown and interpolated for single year.

Fig. 1.—Forest sky line graph for determining location and amount of cut for next five years.

acre; and the upper sloping line representing the average stand per acre at the time of cutting.

The cut for each of the succeeding years is similarly computed and shown on the figure, except that for the 1934 cut one and one-half years' growth is added to the stand as of 1933; for the 1935 cut two and one-half years' growth is added; etc. The area to be cut in 1937 is limited by the number of acres that will have 3,500 feet at the time of cutting. Thus, the average cut per acre in 1937 will range from 1,550 feet per acre to 50 feet per acre for the various stands making up the unit and will average 700.

In this example, the cutting cycle is short because of the accessibility of all parts of the property, the rapid growth of the stands, and the desirability from a silvicultural standpoint of frequent light cuttings rather than less frequent but heavier cuttings. Under other logging, growth, and stand conditions considerable deviation from the kind of cutting budget and management plan illustrated in Figure 1 would undoubtedly be advisable.

The forest sky line graph, as has been stated previously, is merely a graphic reconstruction of the forest inventory, showing in addition the current growth added to the stands. Hence, one could be constructed for any forest property if the essential information were available. The form of management best suited to the forest and the allocation of the cutting budget could then be worked out as in the example illustrated in Figure 1.

The advantage of the graphic presentation of a forest inventory and the current growth in allocating a cutting budget lies in the fact that the forest, its growth, and all the steps in arriving at the final cutting budget, are visualized; the saving in computations is also an advantage. A forest owner can more easily grasp the essential features of the entire management plan from a forest sky line graph of his property with the cutting budget superimposed upon it than from a complicated tabulation. The importance of maintaining a good growing stock is also plainly evident when the graphic method is used.

Now that forest management for sustained yield is one of the aims of the lumber industry and is being considered more seriously than ever before by the individual forest owner, it is essential that foresters make management plans that are practical and easily understood. Less reliance should be placed on theoretical formulae in preparing plans that are to be actually put into practice.

A management plan must begin with the forest as it is and meet the owner's immediate requirements by providing a current cut sufficient to yield him a reasonable income, and at the same time the plan must look to the future and so treat the stands that the cut can be maintained or increased. The method described here is practical, accurate, and understandable and is recommended to others who have management and cutting budget problems to solve.

SOME ANIMAL ASPECTS OF REFORESTATION AND EROSION CONTROL

By WALTER P. TAYLOR

Senior Biologist, Southwestern Forest and Range Experiment Station

The pivotal point to this article by Dr. Taylor is in his recommendation that the control of native-animal life should be considered locally and specifically rather than in general or universal terms. Also that some expert study and diagnosis should be made of a given locality before a comprehensive program of work is set up. The Emergency Conservation program presents a large field for work that it has not been practicable heretofore to program. With that opportunity also comes the responsibility of weighing and deciding the relative need and possible scope that a given activity should take according to locality. There is, in other words, no universally applicable hard and fast sample-plot method of approach to many of our bio-ecological problems.

AS President Roosevelt's huge program for reforestation and erosion control swings into action there is more and more vivid appreciation of some of the opportunities and perhaps difficulties that must be met in making it fully successful.

Where planting is done in areas in which deer, elk, and other big game is superabundant, there may be some adverse effects from trampling down seedlings, injury to buds, biting off young shoots, and the breaking of leaders. In relatively few areas in this country, however, is such injury from game likely to be severe.

The effects of rodent activity, however, may be more far-reaching. Depredations by these creatures, representing the most numerous mammalian order in the world, both in species and in individuals, can put furrows in the brow of every conscientious forester or erosion specialist. Among rodents likely to be encountered are the porcupine, which has often shown itself very partial to small coniferous seedlings, especially ponderosa pine. On occasion it also works on Douglas fir, lodgepole pine, Engelmann spruce, pinons, and other species. Tree squirrels of various species, including the chickaree (*Sciurus hudsonicus*), spruce squirrel (*Sciurus fremonti*), Abert squirrel (*Sciurus aberti*), eastern and western gray squirrels (*Sciurus carolinensis* and *S. griseus*), are notable seed-eaters, and some of them devour the cambium layer and buds on the smaller branches. Rabbits and hares have earned a world-wide reputation as trouble-makers for the forester. Apparently the introduced rabbit has been no inconsiderable obstacle to England's "afforestation" program. There, if success is to be achieved, areas to be afforested must first be fenced against rabbits. Fisher[1] refers to rabbits as a veritable scourge to forestry and agriculture, and writes that they render reproduction of trees exceedingly difficult and expensive. Farrow[2] says the great increase of rabbits, following the killing off of carnivorous animals, has prevented considerable areas in England from becoming natural pine wood and is apparently bringing on degenerative changes in existing woodland. Even mice, such as the deer mice or so-called white-footed species of the genus *Peromyscus*, sometimes damage the forest. Indeed, Willis[3] observed that rodents, the white-footed mice in particular, destroy a large percentage of the field-sown seeds, the

[1]Forest Protection, in Schlich's Manual of Forestry 4:3-4, 1895.
[2]Journal of Ecology 5:1-18, 1917.
[3]Proc. Soc. Amer. Foresters 9:378, 1914.

rodent loss being so high as to guarantee failure of seeding. He concluded that either the rodent must be controlled or seeding given up. Flint[4] concluded that on the Long Pines division of the Custer Forest in Montana mice did far more damage than cattle to yellow-pine seedlings.

Pearson[5] writes that direct seeding has been a total failure throughout the Southwestern region (Arizona and New Mexico) because of rodents and birds. In a controlled experiment on the Coconino National Forest, Gorsuch and the writer[6] found that almost no seedlings were raised in the open; but where seed beds were protected from livestock, rodents, and birds, an excellent stand was obtained.

Even reforestation by planting may be adversely affected by the rodent population. For example, Show[7] found that in northern California rodents seriously damaged fall plantings and those made on areas more than three years after burning.

Shall we then, in connection with the great reforestation project, try to exterminate the rodents and birds, and kill the game? By no means, for nearly all the rodents and other creatures perform valuable services on occasion to the great community of plants and animals. Even the porcupine is avidly fond of that pest parasite, the western yellow pine mistletoe, which it enthusiastically consumes on all possible occasions. The tree squirrels perform notable service as planters of pine seeds and pine cones. The squirrels are also important elements in the recreational attractiveness of the wood. The famed white-tailed squirrel (*Sciurus kaibabensis*) of the northern division of the Grand Canyon National Park is of this character, certainly one of the most famed denizens of this attractive wilderness, and very properly given absolute protection.

Under natural conditions, even rabbits are probably valuable elements in the community. They afford sport to the hunter, their pelts may be useful for felting, and they serve as a safety factor to distract and divert the attention of carnivorous species from more valuable game, a principle too little recognized in this country, but attested by careful observers in Canada and England, and appreciated by various observers in a number of localities in the United States.

Mice and other burrowing species, notably the pocket gopher in many of the forests of the West, are continually cultivating the soil, letting in water and air, carrying down vegetation, bringing up earth, in general helping the great soil complex to function. There is little doubt that all these creatures have their place in maintaining the natural equilibrium between soil, climate, plants, and animals. Although under certain conditions some of these features must be controlled locally, the operation should be performed only after a careful diagnosis, and only by specialists. Otherwise the patient, old Mother Nature, and with her her obstreperous and sophomoric offspring, man, may be more injured than benefited.

In general the carnivorous habitants of a forest area are friends of the trees. They work on the herbivores, exercising a regulatory effect, which though nobody has satisfactorily measured, is not only appreciable but important. Birds are probably more beneficial than harmful to the forest. While some eat seeds and buds, practically all, on occasion, consume insects, as a rule species that are more herbivorous than carnivorous.

Out of this very general discussion let me draw a few conclusions that to my mind apply to the reforestation problem:

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[4]Service Bul., Forest Service 8:6, 1924.

[5]Rev. Forest Service Investigations 2:82-85, 1913.

[6]Taylor and Gorsuch, Journ. Mamm. 13:218-223, 1932.

[7]Ecology 5:94, 1924.

1. Animal phases of reforestation and erosion control are important, and should have the keenest and most adequate possible consideration in the administration of field work.

2. The following features should be considered for each reforestation or erosion-control area:

(a) The importance of the various species of game, predators, rodents, and birds occurring on the area.

(b) The probable relations of each important species to reforestation, to grazing, to agriculture, to wildlife management, to soil conservation, or to erosion.

(c) The determination of what can and should be done to limit or eliminate the activities of those with tendencies of an economically detrimental character; and how to conserve and increase those having beneficial tendencies.

(d) The specific policies in wildlife management (including game, predators, rodents, and birds) that should be applied on each area.

3. A great deal of further research work is necessary if the reforestation, erosion-control, and other problems are to be handled aright.

4. An intensive bio-ecological study should be made of each area where reforestation or erosion-control is to be given attention.

5. Rodent or predatory-animal control should be local and specific, not general and universal, and should be decided on only after careful investigation. The utmost conservatism and the most scrupulous care should be apparent at each phase of every wildlife control campaign, which should be conducted only under trained foremen who know what they are doing. Animal killing should never be assigned to unsupervised dollar-a-day men. The trained foremen should be held carefully to account.

6. Administration and supervision should be of the most rigorous kind, so as (a) to conserve and protect innocent, harmless, or beneficial forms of wildlife, (b) to carefully restrict the killing of the detrimental species to the particular areas where they are clearly detrimental, and (c), even in such areas, to reduce them only to the requisite point.

7. Man must conduct the work to suit himself; but unless he exerts his intelligence, through acquisition and application of pertinent information, he is likely, through over-enthusiastic and ultra-drastic rearrangements of nature, to injure his own interests.

8. It is fortunate for the interests of wildlife, trees, and man, that the trained and sympathetic personnel of the U. S. Biological Survey and their federal and state coöperators are being looked to in planning the work in wildlife research, control, and conservation.

THE FOREST MARGIN

By FRANK A. WAUGH

Professor of Landscape Architecture, Massachusetts State College

Silviculture and forest ecology are commonly studied with reference to the homogeneous forest interior; but the forest margin has a quite different ecology, presenting plant associations which are not only interesting in themselves but are of special importance to landscape architects. And inasmuch as foresters are called upon more and more to consider seriously the scenic aspects of woodlands, they, too, should observe and strive to understand the significance of this forest margin ecology.

FORESTRY has devoted long and intensive study to the ecological composition of the forest. Silvicultural deals largely with these materials. But silviculture has regard to the interior of the forest, proceeding on the assumption that the area under investigation is homogeneous. Landscape architecture, by contrast, has regard mainly to the forest margin, i. e., to that outer zone in which the forest shades off into prairie, meadow, lawn or lake. In a broad general way, subject to important exceptions, it may be said that the landscape architect's main interest in the forest attaches to this narrow outer rim. In those parks and private estates where he finds his chief theater of operations, woodlands of any appreciable acerage are rare, while bordering plantations, many of which from the outside look like forests, are numerous. It is the commonest artifice of the landscape architect to make a thin fringe of trees and shrubs look like a solid mysterious enticing woodland—like the "impenetrable forest" if possible.

Now since it is the work of the landscape architect thus to deal extensively with woodland borders, he ought to make adequate studies of their appearance and composition in nature. For these forest margins have an ecology of their own. The conditions are manifestly different from what they are within the forest or in the outlying sunny meadow. There is in fact a rapid transition from shade to full sun, with all the intervening degrees of partial sun and shade rapidly succeeding one another.

As in all such problems it would seem that the quickest and surest way to gain an understanding of the facts would be to examine a number of examples in the field. The larger the number of such examinations, and the more widely diversified geographically, physiographically and ecologically, the more illuminating they will be, providing always that such surveys have intelligent interpretation. The present writer has made many studies of this sort, mainly in Massachusetts and in eastern Quebec, but also in other parts of the country, from which two typical sketches are offered herewith.

Example 1

OLD LAKE SHORE

Shore of Extinct Lake Hadley, Amherst, Mass.

Sloping gently to the west; old lake beach, sandy and arid, land above the beach sand and gravel from glacial moraine.

Zone A. Woodland.

Forest Cover: Pitch pine, (*Pinus rigida*)[1] AA[2] Good stand estimated 40-50 years old.

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[1] Since this article has been prepared primarily for the use of landscape architects, the nomenclature followed is that of "Standardized Plant Names," Salem, 1923; supplemented where necessary by Gray's "New Manual of Botany," 7th Ed., New York, 1908.

[2] AA signifies numerous and typical; A fairly abundant.

Undergrowth: Sparse, of young pitch pine and gray birch.

Ground Cover: Scant; Maianthemum (*Maianthemum canadense*); Moss.

Zone B. Transition zone, gentle slope with thick growth of young pitch pine; also in small quantities the following:

Common juniper (*Juniperus communis*)
Gray birch
Hardhack (*Spirea tomentosa*)

And, on ground, many gray lichens.

Zone C. Woods margin.

Pitch pine, young specimens, scattered.

Gray birch, few
Hardhack A
Dewberry A
Cinquefoil (*Potentilla* sp.) A
Yarrow (*Achillea millefolium*)
Lambkill (*Kalmia angustifolia*)
Gray lichens and sparse grasses

Zone D. Open pasture, scant grasses, goldenrod abundant, hardhack and considerable gray lichen.

Example 2

TAMARACK SWAMP

Foster, P. Q.

Small swamp with sphagnum bottom, wet, but no standing water in August; has been cut over and has now grown up with larch (tamarack) and mixed woods, maximum age estimated at 30 years.

Zone A. Swamp forest.

Forest Cover: thickly grown

American larch (*Larix laricina*) A
Gray birch A
Sugar maple
White spruce (*Picea canadensis*)

Undergrowth:

Willows (*Salix* sp.)
Nannyberry (*Viburnum lentago*)
Hardhack
Pink meadow spirea
Dwarf blueberry
A few grasses
Sphagnum moss

Zone B. Transition zone, young larch (abundant) gray birch, willows, nannyberry; also the following:

Withe-rod (*Viburnum cassinoides*)
Blackberry (*Rubus* sp.)
Mountain holly (*Nemopanthus mucronatus*)
Chokeberry (*Aronia* sp.)
Highbush blueberry
Brake (*Pteridium aquilinum*)
Strawberry (*Fragaria vesca americana*)
Various grasses, heavy growth

Zone C. Open swampland; a heavy growth of grasses and sedges, willows abundant, strawberry abundant, small viburnums abundant, blueberries, hardhack, pink meadow spirea, chokeberry.

INTERPRETATION

From these brief notes, and even from an abstract consideration of the conditions of the problem, it becomes clear that the composition of forest borders varies greatly. Each case involves local conditions of soil, drainage, exposure and aspect, all of which have an influence in determining the resulting plant society. Yet the landscape architect must not despise nor cannot evade the complex conditions of such a problem, for this is precisely what he has to meet in every one of his planting plans wherein he essays to compose woodland borders of his own.

Though it may be impracticable to supply a standing list of species characteristic of woodland borders, certain generalizations applicable to the problem still seem possible. In a somewhat tentative manner we may suggest the following:

A. The influence of the open country extends back into the woodland for a considerable distance.

1. The marginal trees are lower headed and wider branching than those in the interior and they have a striking tendency to branch toward the light and to lean in the same direction.
2. The undergrowth of shrubs extends from the margin into the forest, diminishing in size, in the number of plants and in the number of species as the distance from the margin increases. Some species penetrate further than others into the forest, generally presenting a faintly discernible zonal succession.
3. The ground-cover likewise shows some succession of species and marked changes in intensity as we move from the open country to the forest interior.

B. Conversely the influence of the forest extends outward to a considerable distance into the adjoining open land. Even upon well-kept lawns this influence is clearly visible.

1. Shade and protection from wind have their own effect. The trees send their roots to a certain distance and by taking moisture from the soil produce a zone of comparative drought. This effect is sometimes obscured or completely offset by the shade and the protection from drying winds.
2. There is usually a tendency for small shrubs and herbs ("weeds") to spread from the protection of the forest further and further into the open. In a sense they are driven forward by the forest.
3. The landscape architect, who is usually interested in the pictorial display of flowers and foliage, will note that certain species show with particularly happy effect when growing here against the woodland border. Those of high luminosity, as whites, blues and light yellows, are especially noticeable.

C. The transition zone, lying immediately at the forest margin, is particularly interesting, rich in species, thickly developed and especially tempting to the artistic eye of the painter or landscape architect.

1. This zone is characterized by the presence of many shrubs. Both species and individuals are multiplied.
2. Herbaceous species are also often characteristic of the woodland border.
3. In general the herbaceous species tend to develop in a zone exterior to the shrubs.
4. There is usually a strong tendency for the tree species of the forest to encroach upon the open land. Young specimens of forest species may therefore appear quite abundantly in the transition zone.
5. The ground cover of the forest usually penetrates into the transition zone at one side, while the meadow grasses and other species belonging to the adjoining open country encroach upon it from the other side.

D. Obviously these zones are not sharply marked. They grade into one other; yet the main facts of the rapid transition are always quite plain.

E. Analysis will nearly always distinguish three zones quite clearly. Not infrequently five or six zones, each characterized by one or two particular species, may be differentiated; sometimes even more.

F. The total spread of these zones varies considerably. The entire transition may be effected within a distance of 50-100 feet, or it may extend over several hundred.

MARGINAL SPECIES

In spite of all difficulties, the student who conscientiously examines a considerable number of forest borders in any given locality will soon discover that certain species occur with marked frequency. They might properly be entered

with discreet qualifications here and there, in a list of characteristic forest margin plants. For example, in the northeastern states the common sassafras is notably partial to the forest margin; so are the gray dogwood and the pagoda dogwood (*Cornus alternifolia*). The flowering dogwood (*C. florida*) and the staghorn sumach (*Rhus typhina*) found so frequently along the woodland margin that they may fairly be entered in the list. Wild grapes of various species belong almost exclusively to this forest margin. A few other trees and shrubs found less commonly yet quite characteristically in the same conditions are native plums, wild apples, prickly ash, choke cherry, chokeberry, certain blueberries and huckleberries, black locust, nannyberry, withe-rod, winterberry, spicebush, witch hazel, hazelnut, etc. A first class example may be found in the blue wood aster (*Aster cordifolius*). Every plantsman can —and should—extend this list for himself.

PRACTICAL APPLICATIONS

Studies of forest margins along the lines here projected might conceivably have some slight interest for the general ecologist or for the forester, but their practical value inures mainly to the landscape architect. Indeed the applications in landscape architecture have been the prime objective from the outset of the present surveys.

First of all it will seem that the man who is designing parks and private estates and who is obliged to construct woodland borders of all sorts and dimensions, would find it convenient, if indeed not obligatory, to make a detailed study of all the woods margins in the neighborhood of any project which he is undertaking. Such examinations, if made intelligently and with due regard for interpretation, will assuredly supply many useful suggestions as to details, not to say a groundwork of solid principles for design. Even in larger problems, such as arise in the conservation and development of state parks, national parks and forests used for recreation, due attention should be paid to these highly significant transition zones lying between the forest areas and adjacent open lands.

On the other hand, in the smallest works of the landscape architect, practical application of these observations may also be made. For example, the "facing down" of shrubbery groups involves exactly the same principles. The simplest foundation planting may thus be given a face either natural, unobtrusive, and gracious, or else harsh, stiff, artificial to the point of the impossible.

This common practice of "facing down" landscape plantings results, of course, in a sort of zonal arrangement of varieties comparable to the zonal groupings arising naturally along forest margins. In actual work it is necessary to exercise great caution in this method of planting. Carelessly done such plantings soon exhibit merely concentric rows of successive varieties. Who has not seen "informal" groups of trees and shrubs edged stiffly with outer bands of Japanese barberry, even of pachysandra, aegopodium or sweet alyssum?

Special difficulty arises where mowed lawns adjoin woodlands or masses of trees and shrubs. The hard line of demarcation is seldom agreeable to the eye, and, of course, such a line is almost certain to destroy any illusion of naturalness. It would seem possible, however, upon a more thorough study and a more conscientious application of the data to be found in nature to make adjustments which would enhance the naturalistic qualities of the picture and presumably at the same time make it more agreeable to the fastidious eye.

THE STRUMELLA DISEASE IN SOUTHERN CONNECTICUT[1]

By C. B. BIDWELL and W. C. BRAMBLE[2]

Serious losses in oak in southern Connecticut are caused by the Strumella disease, which is widespread throughout the Northeastern States. Stands are attacked early in their life, and extensive cankers develop slowly in the trunks of infested trees. Diseased trees are gradually killed, and those that survive to merchantable age have large cankers on the trunk. Most of these cankers occur in the first eight feet of the stem, rendering the valuable butt log practically completely worthless. Control can be effected by removing infected trees early in the life of the stand and by felling dead trees.

THE Strumella disease is an important factor in the silvicultural management of hardwood stands in southern Connecticut. This canker-forming disease, attributed to the causal fungus *Strumella coryneoidea* Sacc. and Wint., is found most frequently on various species of oak, notably red oak (*Quercus borealis*) and black oak (*Quercus velutina*), and less commonly on other hardwoods. The damaging effect on the oaks, which are the most important hardwood timber trees of the region, has made the Strumella disease of sufficient importance to merit the attention of foresters in connection with the management of hardwood stands. According to Hawley and Maughan (2), the Strumella disease is the most serious disease affecting oaks in the Eli Whitney Forest near New Haven, Connecticut, and considerable attention has been given to its control in cutting operations.

Probably the first published description of the canker disease now known as the Strumella disease was the report made by Buckhout (1). Buckhout pointed out the undesirability of red black oaks in the forests in the vicinity of State College, Pennsylvania, because of a fungous disease. The causal organism was not definitely determined by Buckhout, but the symtomology so closely resembled that of the Strumella disease that it seems likely that he had the same trouble under observation. Apparently little or nothing was known of the disease among pathologists until it was again brought to light in Pennsylvania during the study of chestnut blight, 15 years after its first recognition by Buckhout. At this time Heald and Studhalter (3) reported a serious disease of chestnut and oaks which they named the Strumella disease after the fungus, *Strumella coryneoidea,* that was found invariably associated with the disease. They also made successful inoculations with this fungus in the field. The symptoms of the disease and the causal organism were described by Heald and Studhalter in sufficient detail to enable foresters and pathologists to recognize it in the field, but they did not describe the damage caused to the stand as a whole.

The purpose of the present paper is to describe the Strumella disease, as it occurs in Connecticut, and to indicate the extent of the damage caused by it in the hardwood stands surrounding New Haven, Connecticut. The data presented were obtained from the Eli Whitney Forest of the New Haven Water Company which is under the supervision of Professor R. C. Hawley, whose permission made this work possible. It is considered that

[1]This paper is a composite of the theses of W. C. Bramble and C. B. Bidwell presented to the Yale Forestry School in partial fulfilment of the degree of Master of Forestry. Acknowledgements are made to Dr. J. S. Boyce and Professor R. C. Hawley of the Yale Forestry School for their supervision and advice.

[2]The names of the writers are arranged in alphabetical order, since the work was about evenly divided.

the conditions existing in the Eli Whitney Forest are indicative of the conditions existing in many hardwood stands throughout the Northeastern States.

Hosts and Geographical Distribution

The Strumella disease has been reported from widely separated points in Pennsylvania, New York, Connecticut, and Massachusetts. Furthermore, the fungus, *Strumella coryneoidea,* has been collected in Missouri and Ontario, Canada (3). In light of the present knowledge of its distribution it appears likely that the Strumella disease is a native of the United States and Canada, and is not due to an introduced parasite. It is probable that a detailed survey would show a general distribution throughout the hardwood stands of the northeastern United States.

Fig. 1.—A typical canker type of lesion on a dominant black oak 6 inches d.b.h. The zoned appearance of the Strumella canker is nearly obliterated by the decay of the wood underlying the canker.

The hosts of the disease that have been reported in previous publications may be listed as follows: American chestnut, (*Castanea dentata* [Marsh.] Borkh.); Chestnut oak, (*Quercus montana* Willd.); Black oak, (*Quercus velutina* Lam.); Red oak, (*Quercus borealis* Michaux); Scarlet oak, (*Quercus coccinea* Muench.); White oak, (*Quercus alba* L.).

In addition to these hosts the disease has been found on the following hosts in Connecticut: Swamp white oak, (*Quercus bicolor* Willd.); Pin oak, (*Quercus palustris* Muench.); Pignut hickory, (*Hicoria glabra* [Miller] Sweet); Shagbark hickory, (*Hicoria ovata* [Miller] Britton); Beech, (*Fagus grandifolia* Ehrhart); Red maple, (*Acer rubrum* L.).

From this list of hosts it is evident that the disease has a rather wide range of host species among the deciduous hardwoods of the northeastern United States, and it seems possible that the list will be extended in the future. The important oaks are the most heavily attacked by the disease. An example of the relative frequency of infection to be expected among the oak species is given in Table 1.

These data indicate that red oak and black oak are most heavily infected. Both species are particularly favored in silvicultural practice, and are among the most valuable hardwood timber trees of the region. White oak and chestnut oak are less frequently attacked.

The hickories are less frequently infected than the oaks, and out of the 218 infected trees examined in the survey of the Eli Whitney Forest there was a total of 10 infected hickories. Only one beech and one red maple were found infected in this study. The beech was a living, suppressed tree, 6 inches d.b.h., with a typical Strumella canker on its main stem five to eight feet above the ground. A dead branch arising from the cankered area bore abundant sporodochia of *Strumella coryneoidea.* The red maple was dead at the time of

examination, but a small canker half a foot in length was found with sporodochia of *Strumella coryneoidea* on its dead bark.

Symptoms

The earliest symptoms of the disease are usually inconspicuous and difficult to locate in the field. Observations indicate that infection usually enters through a branch axil, or tissues of a dead branch, from whence it spreads into the adjacent stem. A dead branch stub near the center of the canker is a characteristic feature of Strumella cankers. The first indications of the disease are a yellowish discoloration of the bark usually accompanied by a slight depression of raising of tissue surrounding the point of infection. Such infections usually occur at the base of a dead branch. By removing the outer corky layers of bark covering the lesion, the whitish mycelium may be seen as a thin mat, or as small strands, among the bark tissue.

The typical lesions appearing in the more advanced stages of the diseases are classified by Heald and Studhalter (3) into two groups: the *canker type* (Figure 1) and the *diffuse type*. The canker type was most common on the trees observed in this study.

The *canker type* is the result of the formation of successive ridges of callus by the tree as the fungus extends the lesion. From several cankers examined, each ridge appears to correspond with one year's growth of the tree, and forms a concentric circle with the dead branch stub as a center. Whether the relation between the growth rings and the ridges surrounding the center of infection holds in general requires further investigation. The fungus grows more rapidly lengthwise of the trunk, so that the cankers have an elliptical outline. These elliptical cankers have attained a length as great as 60 inches and extended 24 inches around the circumference of the trunk. Of 256 cankers observed in the present study 86 per cent extended around the tree for a distance greater than one-half the total circumference of the trunk at the point of infection.

In most of the older cankers the dead bark over the infected area is destroyed exposing the decayed wood beneath. In such cases, the typical zoned appearance of the canker is partly obliterated. Other cases where the zoned appearance is lacking are to be found in rough, thick-barked trees where the only visible symptoms may be a dead branch stub surrounded by a depressed area of normally colored bark.

A striking characteristic of cankered trees in the field is a distortion, or flattening, of the trunk which is useful in locating infected trees from a distance. The infected tissue decreases in volume through death and subsequent deterioration of the wood, while the remaining portion of the bole appears to be stimulated in growth, thus giving rise to a distinct crook, or distortion, of the tree.

The *diffuse type* of lesion occurs when the fungus grows rapidly and girdles the trunk of the host before a callus is formed. A sinking in of the lesion may take place, but there is no zonation as in the canker type. The diffuse type of lesion is more often found on smaller trees up to 3-4 inches d.b.h. In a few cases, however, diffuse lesions have been found on trees up to 8 inches d.b.h., while zoned cankers have been found on stems as small as 2 inches d.b.h., killing them within a few years' time.

Table 1

RELATIVE FREQUENCY OF INFECTION AMONG OAKS BY SPECIES

Species	Oaks per acre	Infected oaks per acre	Per cent of oaks infected
	Based on 12.7 acres		
Red oak and black oak	28	3.9	13.9
Scarlet oak and pin oak	10	.5	5.0
White oak and chestnut oak	102	3.2	3.1

It should be recognized that intergradations between the two extreme types are common and that various forms of cankers occur which have certain characteristics of both the canker type and diffuse type. For example, a semi-diffuse type may be found on larger trees, in which case the fungus almost completely encircled the trunk before a callus forms just prior to complete girdling.

When the tree is completely, or sometimes only partially, girdled, sprouts are commonly produced in varying numbers just below the cankers. If abundantly produced they form a conspicuous growth which is visible for considerable distance. After the sprouts are subsequently killed in the course of the disease, *Strumella coryneoidea* fruits on them abundantly.

In connection with identification of Strumella cankers, the occurrence of a similar type of canker attributed to *Nectria coccinea* (Pers.) Fr. on oaks and other species of deciduous trees should be taken into account. Frequently both cankers occur in the same stand, and each has the same typical zonation of successive layers of callus about a central branch stub. The Nectria cankers, however, are usually circular in outline in contrast to the elliptical Strumella cankers, and the exposed wood is hard and dry, rather than partially decayed. The small, reddish, hemispherical fruiting bodies of *Nectria coccinea* may usually be found at the edge of the canker and serve as the chief distinguishing character.

Causal Organism

The fungus, *Strumella coryneoidea,* was found invariably associated with the cankers and determined as the cause of the disease by Heald and Studhalter (3). It is not a new species, but an old one that had been previously known only as a saprophyte. The same fungus was found associated with the disease in Connecticut.

Prior to the death of the branch or stem, scattered black nodules are commonly found on the cankered bark. Sections cut through these nodules show them to be made up of a mass of hyphae, anastromosed to form a black carbonaceous nodule. Spores are lacking on these nodules, and it is not uncommon to find open cankers of considerable size and age without signs of the fungus other than these sterile bodies. Occasionally the fungus develops sporodochia on dead areas of cankers on living trees, but usually fruiting is restricted to dead branches and sprouts, or the bark of trees that have been completely girdled. Table 2 shows the number of living infected trees and the number of dead infected trees which were producing fruiting bodies of *Strumella coryneoidea* and the location of the fruiting bodies on the trees.

After the branch or stem has been girdled, fruiting bodies appear in large numbers both on the bark of the original lesion and beyond its limits. They are dark-brown powdery pustules (1-3 mm. in diam.) of the type known as sporodochia

Table 2

Production of sporodochia of *Strumella coryneoidea* by oak trees infected with the Strumella disease

	Position of fruiting bodies: On canker only	On dead branch or sprout only	On canker & dead branch or sprout	Total number of infected oaks	Per cent fruiting
Living infected oaks	1	2	6	99	9.1
Dead infected oaks	10	17	20	106	44.0

which produce conidia profusely from the tips and sides of branched conidiophores. The conidia, or spores, are brown, irregularly globose to pyriform, measuring 7-12 $\times$ 4-7 u, and have spiny walls. The conidiophores are also brownish in color with slightly spiny undulating walls. When mature the powdery masses of spores may be rubbed off with the fingers as a brown powder. The sporodochia remain on the bark for a number of years and become black with age.

The proof of the pathogenicity of *Strumella coryneoidea,* as given by Heald and Studhalter, rests upon a constant association of the fungus with the Strumella disease and successful inoculations in the field. This fungus was also found fruiting on the diseased trees in Connecticut, and appeared to be invariably associated with the type of canker attributed to the Strumella disease. In order to substantiate the field evidence regarding the causal parasite, approximately 200 cultures were made from 9 Strumella cankers of different types. Pure cultures were readily obtained from the diseased specimens when tissue transfers were made to culture media in test tubs and petri dishes. Three per cent dextrose medium was used for the most part. Cultures from the bark tissue at the edge of the lesions, from decayed sapwood of the cankers, from tissue immediately beneath the sterile nodules and sporodochia of the fungus, and from the mycelial strands under the bark all produced but a single constant type of culture with the few exceptions to be expected in isolating an organism in pure culture from that type of material. This type produced a white cottony mycelium which turned grayish-white in from 7-10 days. A characteristic brown or black coloration soon appeared on the underside of the colony, usually beginning at the center and spreading outwards. The density of the undercoloration appeared to vary with different strains of the fungus and the type of culture medium used. The coloration was caused by a compact layer of dark-colored mycelium formed beneath the colonies or where the colony came in contact with the glass walls of the container.

The fungus grew well, but did not fruit in culture on any of the types of media employed. The agar media used were three per cent dextrose, malt, prune, corn meal, red oak bark extract, and three per cent dextrose plus red oak bark extract. Sterilized green beans and sections of red oak stems were also used to culture the fungus.

An attempt was made to germinate the spores of *Strumella coryneoidea* collected from sporodochia on infected trees in the field. Spores were collected from October until the middle of May. Some were tested at once, while others were allowed to remain in the laboratory at room temperature for a week or more. The spores were dusted over the surface of nutrient agar in petri dishes and embedded in poured plates. The hanging drop method using Von Tieghm cells was also used with various solutions and under several different conditions. The drops were composed of distilled water, tap water, bark extract, sucrose solutions, and a number of common nutrient agar media. The cells were exposed to room temperatures and seasonal air temperature during winter months under both light and dark conditions. A few lots were treated with hot water, and others were put in a refrigerator at 3-6 degrees C. for from 1-11 days. The only promising results were from the cold treatment of spores collected in the spring. In a few cases, spore masses produced hyphae, but single spores were not observed producing a germ tube in any case.

Effect on the Host and Damage to Hardwood Stands in Southern Connecticut

The effect of the disease on individual trees is of a two-fold nature. The cambium is killed, and the tree girdled by the fungus growing in the bark. This killing effect

is most pronounced in the diffuse type of lesion. There is also a slow decay of the wood underlying the canker that results in a weakening of the trunk at that point. When decay has progressed to a sufficient degree, the tree may be broken off at the canker by wind, or snow and ice, before complete girdling has taken place. This second type of injury is frequent in the canker type of lesion, in which at the same time, the girdling process is taking place in the bark. Whether or not *Strumella coryneoidea* is responsible for the decay seems to be somewhat questionable, although Heald and Studhalter state that this fungus is responsible for the disintegration of the wood, as well as the killing of the bark. The same type of fungus may be isolated from decayed sapwood under the lesions as from the infected bark at their growing edge, but in several cases a wood rotting fungus has also been isolated.

In the field, fruiting bodies of *Daedalea quercina* L. have been observed in cankers of the open type. The fact remains, however, that decay of the underlying sapwood is an invariable accompaniment of the cankers and must be taken into account when dealing with this disease.

In the present study the majority of the cankers were found within the first 8 feet of stem above ground level, thus making the valuable butt log partially, or entirely, worthless. Data on this point are summarized in Table 3. The cankers may occur from approximately ground level up to a height of 30 feet on the tree. Practically all cankers were on the main stem, but occasionally they were found on branches.

Table 3

LOCATION OF STRUMELLA CANKERS ON THE MAIN STEM OF INFECTED OAKS

Distance above ground in feet	Number of cankers	Percentage of cankers
2-4	130	39.7
5-8	122	37.2
9-12	48	14.6
13-20	23	7.0
21-40	5	1.5
Total	328	100.0

The growth of the canker appears to be comparatively slow according to the indirect evidence available on this point. In several cankers that were examined, it had required from 5-6 years to girdle stems 2 inches in diameter. Actual measurements taken on 4 cankers over a period of one year showed a negligible rate of advance. The weathered appearance of cankers on large trees also may be taken as a likely indication of their slow growth.

While it is true that no cases have been observed where the host has recovered from the disease, several cases have been found where the cankers are obviously being covered over by callus tissue. It seems probable, however, that even in these cases the decay entering from or through the cankers would greatly impair the timber value of the trees.

From general observations in the field and some data related to the subject, the writers are led to believe that by far the largest number of infected trees in even-aged stands are attacked before the stands are 20-25 years old. Most of the cankers in an even-aged stand approximately 25-30 years old and covering 35.4 acres appeared quite weathered and old, having a number of ridges of callus growth, thus indicating infection some years previous. Since the fungus is considered to enter the tree mainly through dead branch stubs, infection must occur before the trunk is completely pruned above the height of the canker. On the area of 35.4 acres 84 per cent of the total of 68 cankers were found within the first eight feet of the bole above the ground, and 77 per cent of the 328 cankers examined in the entire study also occurred below 8 feet. Although it was impossible in this study to take any definite data on the age at which oaks in even-aged stands prune themselves to this height, general observations indicate that the oaks in a stand of

20-25 years of age have pruned themselves to a height of over eight feet. In the same 25-30 year old stand 84 per cent of the 37 oaks killed by the fungus were included within the 1-4 inch diameter classes, which indicates that most of the infected oaks were attacked before they reached five inches in diameter breast high. Considering the slow rate of growth of the cankers in conjunction with the above data, it seems probable that most of the infected trees in an even-aged stand are attacked before the stand is 20-25 years old. The low degree of infection in the 1-20 year age class, as compared to that in the 21-40 year age class, in Table 4 may be explained by the fact that the data were necessarily taken from different stands, and that the incidence of the infection is variable.

The Strumella disease appears to attack the vigorous trees, which are in the dominant and codominant classes, just as readily, if not more so, than the suppressed individuals. Of the 218 infected trees examined, 21 per cent were classed as dominant and codominant. However, this figure probably does not give the entire picture, as it would be much higher, if the history of each tree could have been followed. It would be expected from the nature of the injury caused by the cankers that the vigor of the trees would be considerably lessened by the continued attack of the fungus. Thus many of the less thrifty and even some of the dead trees were very likely in the dominant and codominant classes at the time of attack. As the fungus works slowly in the canker type of lesion, the trees had a number of years in which to be reduced to their present degree of vigor.

Although clumps of sprouts are found frequently in immature stands, in which some of the individuals are infected, while their neighbors are in a healthy condition, in mature stands all of the sprouts in a clump often become infected. However the productivity of a sprout stand may be seriously decreased even when one or two individuals in each sprout clump remain free from infection. Although the most common mode of infection is apparently by wind disseminated spores, occasionally a canker at the base of one sprout spreads and infects an adjacent one, and in time may attack the entire clump.

The Strumella disease does not reach epidemic proportions, and affects only a small percentage of the total number of oaks in the hardwood stands of southern Connecticut under observation. This is indicated by the data presented in Table 4. The disease cannot be dismissed as a desirable agent in natural selection, however, as it adversely affects the stands through reduction in value and removal of the most valuable oak species (Table 1). The slow attack on the productivity of the stands through damage and removal of the oaks makes the disease of importance in the silvicultural management of hardwoods stands.

Control

The present method of control by removing the infected trees in cutting operations (2) appears to be the logical measure. It is relatively inexpensive and can be made efficient, if well done. There are some additional facts, however, that may be used to advantage in such cutting operations.

The indications are that the disease, with a few exceptions (see Table 2), spreads only from killed trees or from infected dead branches of living trees, and that the conspicuous cankers on living trees without adjacent branches or water sprouts are not dangerous so far as immediate reinfection is concerned. It is important, therefore, to remove the diseased trees during the early stages of the disease before death and profuse fruiting occurs. The early stage of the diffuse lesion may be recognized by a yellowish discoloration of the bark that stands out in contrast to the darker normal bark; the infection usually occurs in connection with a dead branch or

branch stub. The canker type may be readily recognized in the stages following the incipient discoloration by the depressed bark and concentric ridges of callus tissue surrounding a dead branch or branch stub. In such cases, although the tree may not be girdled for years, the fungus may fruit on the branches adjacent to the canker or on killed water sprouts, and occasionally on dead areas of the cankers. It is advisable to remove the cankered trees, or when that is not possible, to knock off the adjacent branches and water sprouts.

In addition all standing dead trees or snags should be removed or at least knocked down, since 44 per cent of the 106 standing, dead trees with cankers were producing fruiting bodies when examined and would continue to do so, as long as they remained standing with the bark intact. The bark disintegrates and sloughs off rapidly on down trees, but it remains intact for a long time on standing dead trees. The fungus fruits only on dead bark. Special care should be taken to knock down small dead trees, since 70 per cent of a total of 47 dead trees with fruiting bodies were 3 inches d.b.h. and under.

TABLE 4

PERCENTAGE OF INFECTION AMONG THE OAKS IN HARDWOOD STANDS IN SOUTHERN CONNECTICUT[1]

Age class of stand (years)	Percentage of oaks per acre	Percentag of oaks infected per acre	Number of acres basis
	Maltby Division		
1-20	53.5	1.2	22.8
21-40	50.3	4.1	50.2
41-60	54.0	0.7	13.9
61-80	47.6	2.5	42.8
81-100	73.0	0.0	1.9
	Madison Division		
Unevenaged	65.3	5.5	12.7
	Seltonstall Division		
Unevenaged	24.8	0.0	92.3

[1]Obtained by strip surveys covering from 10 to 100 per cent of the areas designated under "Number of acres basis."

SUMMARY

The Strumella disease, attributed to the fungus *Strumella coryneoidea* Sacc. and Wint., is the most serious disease of oaks in southern Connecticut. It has also been reported from widely separated points in Pennsylvania, New York, Connecticut and Massachusetts. The fungus is probably native to North America.

In southern Connecticut, red and black oaks are most commonly infected, while white and chestnut oaks are less frequently attacked. The hickories are occasional hosts, while one beech and one red maple were found infected. Elsewhere, chestnut is also occasionally diseased.

Cultures of a uniform type were readily obtained from diseased tissue, but the fungus did not fruit in culture. All attempts to germinate spores collected from fructifications developed naturally were unsuccessful.

The disease results in distinct lesions on the main stem, either of a diffuse or canker type. The cambium is killed and the tree girdled by the fungus growing in the bark, while there is also a slow decay of the wood underlying the cankers. Growth of cankers is usually slow and an infected tree may live for years before it is finally girdled. Most trees are infected before they are 20 to 25 years old and vigorous trees appear to be as readily attacked as slow growing ones.

While the percentage of oaks attacked ranged up to 5.5 per cent, the actual damage was serious, because oaks are the most valuable components of the mixed hardwood stand in southern Connecticut. Seventy per cent of the cankers occurred on the first 8 feet of the stem, thus making the valuable butt log partially or entirely worthless.

Control can be effected by removing infected trees, both living and dead, early in the life of the stand. If the dead trees can-

not be removed they should at least be felled, so that the dead bark, on which the fungus fruits, will disintegrate and slough off rapidly.

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Civilian Conservation Corps Camp Number 59 at the Arnot Forest, property of Cornell University, is in full operation. Work projects concern themselves primarily with truck trail improvements and silvcultural operations in stands of second growth hardwoods and hemlock. The system of truck trails is planned with a view to making the entire forest accessible for purposes of protection, utilization, silvicultural research and the general admnistration of the property. The immediate silvicultural work consists of improvement cuttings of various types and the disposal of material which at present constitutes a fire hazard. In the spring a considerable amount of land will be reforested. The camp has an Army staff of four men and a technical supervisory personnel of eleven men. There are 200 enlisted men engaged in carrying out vigorously the various projects. The establishment of a C.C.C. camp on the Arnot Forest will make possible a series of developments which would otherwise require many years to complete.—R. S. Hosmer, *Cornell University.*

HOW MOTOR TRUCKS ARE USED IN DOUGLAS FIR LOGGING

BY E. F. RAPRAEGER

Pacific Northwest Forest Experiment Station

Last year Mr. Rapraeger made a study of the use of motor trucks in log hauling in Oregon and Washington for the purpose of pointing out the conditions under which they can be economically employed and to determine the factors contributing to their limitations. Since then, three reports have been prepared, one for *The Timberman*, one for the *American Lumberman* and the following article for the JOURNAL OF FORESTRY. This article for the JOURNAL differs from the others in that it describes for readers in other districts how trucks are employed in the Douglas fir region. Our truck loggers are using motor vehicles under conditions which are often extremely difficult. To overcome these obstacles, they have designed new equipment and developed better loading and hauling methods, many of which are applicable to regions facing similar conditions.

MOTOR truck log transportation has been used in the Douglas fir region since about 1913 when, in the state of Washington, an auto vehicle pioneered in hauling long logs from the woods to the sawmill. Various mechanical troubles were frequent in the early vehicles and the poor traction obtained by the conventional solid tires then in use, limited the hauling of large loads of logs to the better highways. In the past fifteen years, however, many new highways have been built and, together with progressive designs in mechanical equipment, tires and accessories, have contributed to the remarkably increased hauling range and utility of motor trucks.

In 1931, approximately 375 million board feet of logs were hauled by motor trucks in Oregon and Washington, this being about one-sixteenth the log production of the two states and one-forty-fifth that of the United States. The hauling was done by nearly 900 trucks, of which 70 per cent operated in the Douglas fir region.

The average haul was between 10 and 11 miles and few exceeded 25. Some loggers haul to tidewater where the logs are rafted, and others to sawmills or railroad points. By far the majority of haulers are public road users for a part of the distance between stump and market. Many are "highway strippers" who, as the term implies, log alongside a highway or in its immediate vicinity. Such locations are much in demand because they offer low road building costs. Their increasing scarcity, however, makes longer hauls necessary, which counterbalances the saving in road construction.

The topographic, timber and climatic conditions peculiar to the Douglas fir region force many problems upon log haulers and create difficulties for trucking equipment. The timber is large, logs are customarily hauled in long lengths, the topography is rugged and the working season over earth roads is short. In addition, truck loggers meet as competitors the large scale railroad operators, who, with mass production methods and excellent marketing facilities, occupy a strong position in the logging industry.

It is the objective of the remainder of this paper to describe how the problems arising from large timber, long length logs, rugged topography, a short hauling season, and the need for low cost logs are simplified by truck loggers of the Douglas fir region.

The average size of log in the region is close to 900 board feet and the range extends from 200 feet to five or six thousand. In large-log timber the capacity of the trucking equipment is adapted to the size of the largest logs. Accordingly, trucks of 3½ to 5 tons or larger capacity are used. These draw semi-trailers of about the same size, hence, the rated load

capacity of the vehicle combination is double that of the truck. To strengthen the truck and increase the load capacity, metal plates are riveted fore-and-aft of the chassis. Wheel capacity is correspondingly increased by using large pneumatic tires. One of the largest trucks employed in the region is a six-wheeled truck two-wheeled trailer combination rated to carry 22 tons on 14 pneumatic tires. In small-log timber, trucks of any capacity from 1½ tons up are used because the size of load is easily adjusted.

Logs are customarily bucked into lengths ranging from 24 to 40 feet. These are too long for the frame of an ordinary truck, hence, a semi-trailer (logging trailer) is drawn behind to support one end of the logs. Such trailers are sturdily built and have a single heavy axle on which dual wheels are mounted. Trailer brakes are used on steep hills or congested highways and are usually controlled separately from those of the truck. Thus, when the speed of the trailer tends to increase, as on steep grades, the vehicle can be retarded by applying the trailer brakes alone.

Truck and trailer brakes are operated either mechanically, by compressed air or by a vacuum from the motor. The two latter controls are used extensively when powerful brakes are needed, as for example, in the descent of mountain roads. Air brakes are better than the vacuum booster type (vacuum brakes), but the latter are more popular because of their low cost. A water cooling arrangement is attached to brakes when used on long continuous grades where they become overheated. Opening the valve of a 50-gallon tank allows water to circulate freely through the brake drums.

The handicap of rugged topography is partly overcome by careful attention to maximum road grades. Favorable grades (with the load) are less of a problem than adverse grades (against the load) because, with powerful brakes, loaded trucks can safely descend grades up which they cannot draw an empty trailer. One operation, along the Columbia River in Oregon, hauls 10-ton loads of logs down a mountain road with a difference in elevation of over 1,100 feet in one and one-half miles. Short stretches of the road have grades of 20 per cent. Each truck and trailer has air or vacuum booster brake equipment cooled with running water. During a year of operation no accidents have occurred though, on one or two occasions, the vehicle was deliberately driven into the bank when the brakes did not function properly. In returning to the woods, the trailer is loaded on the truck. Each truck has a special transmission with nine speeds forward and three in reverse. In returning over the 20 per cent grade on the way to the woods, the lowest gear is used giving a speed of about two miles per hour.

The allowable gradients on a road depend, among other factors, on the size and make of the truck, its horsepower and gear ratios, the load, and the roadway surface. Adverse grades are kept to a minimum and favorable grades also for that matter, although, as mentioned previously, these are controlled not by the load but by the ability to return with the truck and trailer. Generally accepted gradients are given in Table 1. They vary with different trucks but in general may not be exceeded, except on short pitches, without injury to the transmission, differential and other mechanical parts.

In negotiating steep grades on the return trip, the trailer is carried on the truck. The object is to give the drive wheels better traction, to decrease the travel time, and to lessen the risk of accident. Trailers are lifted on the truck at the unloading point with a block and tackle rigged on a gin-pole or any one of other innumerable hoisting devices.

The length of the hauling season is definitely controlled by the condition of

the road after a heavy rain. Earth roads are built in the woods for summer logging and are normally hauled upon during a 60 to 120 day period beginning in early June and ending with the advent of fall rains in September. Midsummer rains, though infrequent, cause a temporary cessation of hauling. Crowning an earth road to facilitate drainage is useless because the shape is not maintained under heavy loads.

During the winter and spring, better roads are built for hauling. Gravel or crushed rock to a depth of from five to eight inches is often used for ballast. The preferred all weather road, however, is not the gravel road but one of the fore-and-aft plank type. This is built of plank laid end to end in two parallel lanes on cross ties. The plank is usually four inches thick and twelve inches wide, and two or three are laid side by side for each tread. The average cost per mile of such a road is about $3,500, which includes an earth subgrade costing about $700.

In wet weather, the steep part of a plank road is kept passable in one of several ways. One method is to spread gravel and another is to zig-zag worn wire rope along the tread and spike it in place. Still another, and perhaps the best, is to fasten stout "hog" wire on the planks and spread gravel over the meshes.

Some motor truck loggers have applied their ingenuity not only to road building but also to loading. Others have followed the lead of railroad loggers and adopted their loading methods. A few of the railroad car loading systems, like the McLean boom, are often equally suited to cars or trucks.

Truck loading differs from railroad car loading in several respects. The cars are stout and do not require gentle handling of logs and even balancing of loads. Nor do cars require immediate loading on arrival at the landing, the essential requirement being completion of the work prior to the locomotive's return three or four hours later. Motor trucks, however, should be loaded immediately, since they arrive at the landing not in a train like log cars but consecutively and on separate schedules. Also, with motor trucks more log storage space is needed to maintain harmony between yarding and hauling.

Four standard long log loading methods for motor trucks are shown in Figure 1. Sketch C, the McLean boom, is used for both railroad car and truck loading, but the other three are primarily for trucks. The two overhead systems shown in Sketches A and B have an abundant log storage space while the preloading system, Sketch D, has the advantage of reducing loading time considerably.

Operation of the preloading system is shown in four stages by Drawings 1, 2, 3 and 4. Drawing 1 shows logs which have been preloaded and now rest on two false bunks that are placed across the two large brow skids. The rear false bunk is shown in position just in back of the deep notch cut in each skid. The distance between the skids is sufficient to admit a logging truck and trailer which in Drawing 2 is backing beneath the lifted load of logs. When the trailer bunk is in contact with the rear false bunk, the lifted

TABLE 1

UPHILL GRADE LIMITS FOR LADEN AND UNLADEN TRUCKS PULLING TRAILERS OVER GOOD AND POOR ROADS IN DRY WEATHER

Rated capacity of truck in tons	Uphill grade limits			
	Laden vehicle		Unladen vehicle	
	Good roads	Poor roads	Good roads	Poor roads
	Per cent	*Per cent*	*Per cent*	*Per cent*
1½ and 2-ton	5-8	4-7	8-12	5-8
2½-ton and larger	7-12	6-10	11-18	8-14

end of the logs is placed on the truck bunk, the front false bunk is removed, and the vehicle slowly moves ahead. As it does so (Drawing 3), the rear false bunk slides into the notch provided for it in the skid and the load shifts to the trailer bunk. The load is chained and while the truck is hauling, another load is preloaded.

The preloading system has been used to excellent advantage by the operator who designed it. It decreased his loading time and increased the load volume and the number of trips made per day. During a 26-day hauling period, the average output in eight hours, using a 5-ton truck and trailer, was 44,930 board feet. The haul was 3 miles long over an earth road, part of which was on an 18 per cent favorable grade. Loads averaved 5,120 board feet with seven logs to the load.

Though motor truck loggers have spent considerable time and thought in overcoming various physical obstacles, they have spent but little energy in improving merchandising methods for their product. Many observers wonder how they can remain in business and meet the competition of large scale railroad operators who have good marketing facilities and are intrenched in the best timber stands. In the log market, the bargaining position of truck haulers is notably weak. They have no central sales agency, each being his own sales manager. As small scale operators hauling frcm isolated timber stands, their timber is variable in quality from month to month and buyers do not offer a steady market for an irregular supply of their logs. Many haulers operate with little or no financial backing and this, added to the other factors, forces them to accept prices a dollar or so per thousand below the regular market.

In spite of these handicaps, most motor truck loggers are able to remain in business against railroad competition. For one thing they have flexible hauling equip-

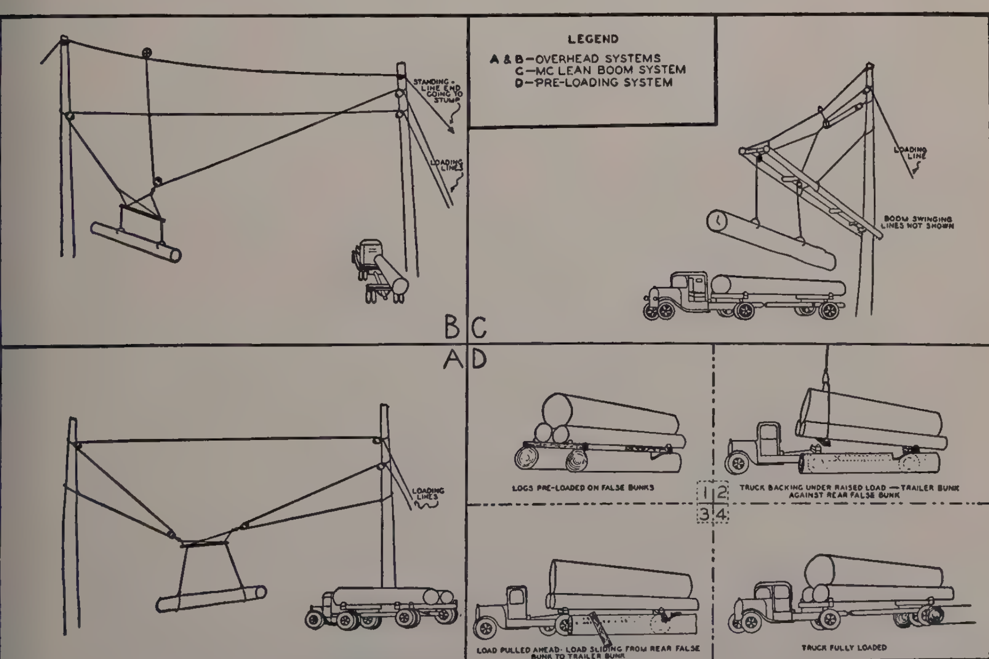

Fig. 1.—Standard motor truck loading methods; A and B are overhead systems, C the McLean boom system, D the preloading method.

ment that permits them to move from place to place and, with the exercise of good business judgment, to select only the profitable logging opportunities. Truck loggers are not timber owners and seldom are forced into high cost logging shows for the purpose of liquidating a burdensome timber investment. The timber they log is in isolated tracts for which trucks are the only outlet and the timber owner can either accept a fair stumpage price or hold his property indefinitely.

The wide latitude permitted in motor road grade and alignment, in contrast to railroad standards, is also an advantage in simplifying yarding and construction problems. Not only may expensive construction be avoided but yarding machinery may be located in more strategic positions, thus reducing the cost of bringing logs to the landing.

Also, the motor truck operation is usually small and has the advantages inherent in small operations. The owner is superintendent, timkeeper and frequently high climber or donkey engineer as well. His intimate knowledge of his equipment and surroundings enables him to practice economies not possible in a larger operation.

It is expected that motor truck use will continue to increase in the Douglas fir region. Highways are being built into previously inaccessible areas and hauling equipment and methods are continually being improved. Railroad operators as they move into the rougher ground and smaller timber will more and more substitute motor truck roads for spur line railroads in the leaner settings. A generation of loggers has established the suitability of motor trucks, corrected old faults, and discovered new merits. They have not developed an equipment for small operations as contrasted to large, but rather one which under the right conditions is the most economical way to haul timber.

VOLUME TABLES TO FIXED TOP DIAMETERS

By R. R. REYNOLDS

Junior Forester, Southern Forest Experiment Station

The author points out that the volume contained in small trees or in the tops of trees, or because of limbiness or small size, may often be unprofitable to log and mill. Board foot volume tables constructed to a fixed top diameter do not take this into consideration and therefore need to be reconstructed or revised. An example for a particular area is given.

RECENTLY studies by the Forest Products Laboratory and others[1] have proven, quite conclusively, that the cutting of trees below certain diameters at breast height is unprofitable. Costs of logging and milling trees below approximately 12 inches d.b.h. for southern pine and 14 inches d.b.h. for southern hardwoods, in a large number of cases, are greater than the value of the lumber produced from these trees. On the average, it costs twice as much to produce one thousand board feet of lumber from shortleaf and loblolly pine trees 8 inches in diameter as from similar trees 24 inches in diameter and further, the lumber from the small trees is worth only about three-fourths as much per thousand as lumber from the large trees.

These statements are true in many cases, and, although this is a step in the right direction, it is not all of the picture. Figuratively, many foresters have not been able to get their eyes off the ground. Scores of volume tables have been constructed based upon a fixed top diameter—many on fixed diameters as small as 5 inches.

In using these tables to a fixed top diameter, without correction, we are doing just what it has been proven unprofitable to do. We are placing a positive value upon board foot or cubic foot material in the tops of trees which, because of small size or excessive limbiness, is unprofitable when cut into lumber or other products. Volume tables should include only board foot material that it is practical to convert into commodities acceptable on the general market.

This paper does not attempt to give a set of figures by which volume tables built up to fixed top diameters may be corrected to conform to actual practice. The writer's purpose is to point out the fallacy of constructing volume tables in board feet to a fixed top diameter and to point out the possible error involved in using such tables to a fixed top diameter without correction.

Fixed Top Diameter Versus Merchantable Top Diameter

In order to determine, for a particular district in southern Arkansas, the relative merchantable top diameter of trees of different sizes, the length of the material between merchantable top diameter and a fixed top diameter of 5 inches, and the volume between merchantable and 5-inch top diameter, use was made of 1109 individual stem anaylses of loblolly and shortleaf pine collected by the Forest Products Laboratory and the Southern Forest Experiment Station.

Merchantable Top Diameters

The trees upon which these analyses were made were cut to top diameters consistent with the utilization practice of the large mills of the region. The top diameter to which any given tree was cut

[1] See references at end of article.

was usually dependent upon the presence or absence of large limbs.

The average merchantable top diameters of trees of different sizes and log lengths are given in Table 1. The top diameters to which these trees were cut varied not only with d.b.h. but also with the number of logs per tree. It is interesting to note that only a very few trees below 10 inches at breast height were cut to anything approaching a 5-inch top diameter. It is also interesting to note that for trees above 20 inches d.b.h. all merchantable top diameters were larger than 11.3 inches. These figures show the fallacy of using a fixed top diameter in determining the volumes for commercial utilization on this particular area. It would no doubt work out differently in other parts of the region.

Length to 5-Inch Top—Above Merchantable Top

As is to be expected the length above the merchantable top to a 5-inch top diameter varies greatly with the d.b.h. It also varies, to some extent, with the number of merchantable logs in a tree. A short summary of the average length by diameter classes is given in Table 2.

Volume in Section Between Merchantable Top and 5-Inch Top Expressed as a Percentage of Total Volume to 5-Inch Top Diameter

Many volume tables for shortleaf and loblolly pine now in use have been constructed to a fixed top diameter limit of 5 inches. Therefore, the correction factor necessary to convert those tabular values to volumes that are commercially usable is of primary importance.

In order to determine this, the merchantable volume[2] and volume to a fixed top diameter of 5 inches were determined for each tree. The volumes of the individual trees were combined by diameter class and curved by log length. However, it was found that the percentage of volume in the top compared to the total volume to a 5-inch top diameter when plotted in this way gave a straight line. That is,

[2]By International ¼-inch Rule.

Table 1

DIAMETER INSIDE BARK,[1] TOP OF MERCHANTABLE LENGTH. SHORTLEAF-LOBLOLLY PINE. SOUTHERN ARKANSAS

Diameter breast high	Shortleaf pine 2 log trees	Shortleaf pine 3 log trees	Shortleaf pine 4 log trees	Loblolly pine 2 log trees	Loblolly pine 3 log trees	Loblolly pine 4 log trees
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
8	5.4			4.8		
9	6.3	5.5		5.7	5.2	
10	7.2	6.3	5.4	6.6	6.0	5.0
11	8.1	7.1	6.1	7.4	6.7	5.7
12	8.9	7.8	6.7	8.3	7.4	6.3
13	9.8	8.6	7.4	9.1	8.1	7.0
14	10.6	9.3	8.0	9.9	8.8	7.6
15	11.4	10.0	8.6	10.7	9.5	8.2
16	12.2	10.7	9.3	11.5	10.2	8.8
17	13.0	11.5	9.9	12.3	10.8	9.4
18	13.8	12.2	10.5	13.1	11.5	10.1
19	14.6	12.9	11.1	13.9	12.2	10.7
20	15.4	13.6	11.7	14.7	12.8	11.3
21	16.2	14.3	12.3	15.5	13.5	11.9
22	17.0	15.0	12.9	16.3	14.1	12.4
23	17.7	15.6	13.5	17.0	14.7	13.0
24	18.5	16.3	14.1	17.8	15.4	13.6
Basis number of trees	90	380	125	68	268	178

[1] Curved values.

TABLE 2

LENGTH ABOVE MERCHANTABLE TOP TO 5-INCH TOP DIAMETER[1]

Diameter breast high	Shortleaf pine 2 log trees	Shortleaf pine 3 log trees	Shortleaf pine 4 log trees	Loblolly pine 2 log trees	Loblolly pine 3 log trees	Loblolly pine 4 log trees
Inches	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
8	12.6			8.4		
9	14.1	8.2		11.0	5.6	
10	15.4	10.1	3.4	13.1	8.2	2.0
16	21.2	17.6	13.4	20.4	17.4	11.6
24	26.8	24.8	24.0	27.2	25.3	21.1

[1] Curved values.

the variation occurs between trees of different log lengths rather than between diameter classes of the same log length. The results are given in Table 3. The figures bring out the fact that trees from which only two logs were cut, due primarily to large limby crowns, have a relatively large percentage of the volume that cannot be used and is, therefore, left in the woods, whereas the 4-log trees have a relatively small amount of total volume to a 5-inch top that is unmerchantable.

TABLE 3

DIFFERENCE BETWEEN MERCHANTABLE VOLUME AND VOLUME TO A 5-INCH TOP EXPRESSED AS A PERCENTAGE OF THE LATTER[1]

Species	Logs per tree	Basis No. of trees	Per cent
Loblolly	2	68	12.33
Loblolly	3	268	6.41
Loblolly	4	178	2.67
Shortleaf	2	90	13.60
Shortleaf	3	380	6.14
Shortleaf	4	125	2.70

[1]These percentages have been checked against two other sets of data from other regions and check within an average percentage deviation of ±1.5. While these percentages would apply to other timber of similar taper, occurring on similar sites, and with the same utilization practice, they should not be used without being checked against the timber to which they are intended to apply.

Board foot and cubic foot material at the tops of trees, as well as small trees, may often be very unprofitable to log and mill. In constructing new board foot volume tables, this fact must be considered and the tables constructed to merchantable top diameters. Volume tables already in use that do not recognize and make some provision for different merchantable top diameters need to be revised.

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ROOT DEVELOPMENT IN SEEDLINGS IN RELATION TO SOIL TEXTURE

By C. H. ANDERSON AND E. G. CHEYNEY

University Farm, St. Paul, Minnesota

THE influence of the edaphic factors upon the root development of seedlings is still more or less of a puzzle. In 1882 Savits (2), working with prepared soils, found that the length of the roots was shorter in the finer textured soils; and Haasis (1), in his study of the roots of western yellow pine seedlings, found the roots longer in clay and shorter in the loamy soil. An experiment carried out by the writers in 1931 partly confirm these results.

The object of the experiment was to determine the effects of soil texture on root growth in relation to moisture content. The results of moisture control were not decisive, but the effects of texture were quite marked.

Eighteen wooden boxes, six by six inches square and six and one-half inches deep, were arranged in three series of six each. Sand dune sand was then sifted through a series of screens ranging from 20 to 100. Five boxes of each series were then filled with these separates. The sixth box was filled with a mixture of the separates.

Norway pine (*Pinus resinosa*), white spruce (*Picea glauca*), and southern balsam (*Abies fraseri*) were used. Twelve seeds of each species, after having been germinated between blotters, were planted in each box, evenly spaced and covered to a uniform depth.

The boxes in series I were given 25 c.c. of distilled water per box per day; series II 50 c.c. and series III 75 c.c. The water was so applied, by means of test tubes sunk into the soil three-quarters of an inch and punctured in the bottom with a pin hole, that it was all readily absorbed and fairly evenly distributed.

When the seedlings had grown in the greenhouse for four months an examination was made of the roots.

The following diagram records the results (Fig. 1).

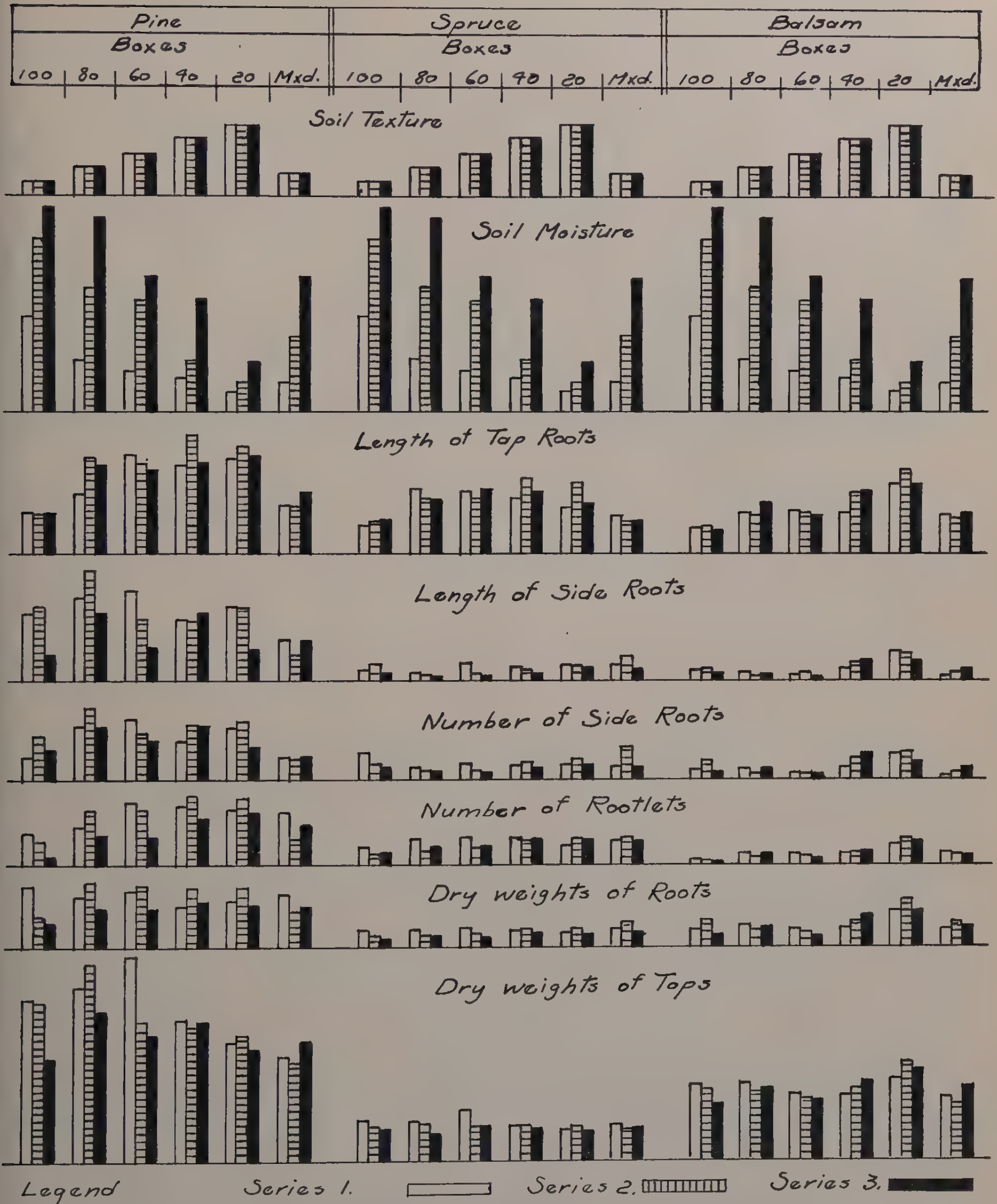
It will be noted that the length of the tap root in all these species, regardless of the moisture content of the soil, shows a quite decided increase from the finer to the coarser soils.

The lengths of the side roots, on the other hand, show no such regular increase, and in some cases show a slight trend in the opposite direction.

This difference suggests a possible difference in the purpose of the two classes of roots. The length of the tap root as Toumey (3) has shown, is largely controlled by hereditary influences and is probably used more for anchorage than absorption. If this is true that the tap root is not primarily a water carrier and therefore not stimulated to find water, its growth depends entirely upon the hereditary urge, and such growth would be hindered by the density of the soil. Roots from soils of high mechanical resistance are the shortest, thus resistance appears to be the most important factor controlling the hereditary tendency.

If the side roots, on the other hand, are not so strictly ordered by heredity and their purpose is absorption rather than anchorage, their length would be more greatly influenced by the available water supply, and the finer the soil the greater the water content. The side roots would, therefore, be shorter in the finer soils because they would not have to grow so long in the finer soils to procure the same amount of moisture.

The differences in length of side roots between the three series are so slight that



Growth values represented in this graph are averages based on ten seedlings.

1. Soil texture is represented by an arbitrary scale.
2. The number of side roots and the rootlets are not based on the same scale.
3. Soil moisture is the moisture present eight hours after watering.
4. Box numbers correspond to meshes of screens used for sifting.

Fig. 1.—A graphic representation of soil texture, soil moisture, and the growth data for the pine, spruce, and balsam.

it is difficult to draw any definite conclusions, but such trend as there is seems to confirm the belief that the greater moisture tends to shorten the side roots.

There is a very decided trend toward a greater number of rootlets (less than five m.m. in length) in the coarser soils.

The evident uniformity of the dry weight of the roots in all the boxes is accounted for by the increased thickness of the shorter roots in the finer soils.

The general result of the study is to give more influence to the mechanical resistance of soils to roots than has generally been accorded to it in the past.

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If you consult almost any text-book on forestry, you will find that the word sport is conspicuous by its absence, and when you enter into conversation with your forester friends the word is only mentioned in so far as ground game is concerned, or in so far as forestry operations have had to be suspended in the plantations during the nesting period. Foresters, in fact, have been at the best neutral, at the worst hostile to sport, and it is this attitude, rather than any other cause, that has been responsible for the lethargy with which the forest problems have been tackled by the average landowner in the past.—Hon. N. A. Orde-Powlett, *Scottish Forestry Journal.*

INFLUENCE OF GLAZE STORMS UPON HARDWOOD FORESTS IN THE SOUTHERN APPALACHIANS

By CHARLES A. ABELL

Appalachian Forest Experiment Station

ALTHOUGH the distorted form of some trees is caused by inherent and environmental factors operating more or less continuously, the abnormal condition of others can be traced to occasional forces of greater intensity. In the latter category of influences are glaze, or ice, storms, characterized by rain freezing to the objects upon which it falls. During such storms branches may be called upon to bear ice amounting to more than 15 times their own weight. The lasting damage caused in forest stands may take many forms. Some individuals are broken off near the ground, shattering of tops deforms others into misshapen wrecks, and the loss of branches is likely to cause reduction in growth. The burden imposed may strain the tree excessively and induce windshake. Open wounds invite the entrance of insects and fungi which are certain to lower the quality of timber.

Occurrence in the Southern Appalachians

Glaze storms occur at relatively frequent intervals in the Southern Appalachians. Older residents of western North Carolina recall at least four within the past 75 years. Rhoades[1] reported widespread damage from an ice storm throughout portions of Pisgah National Forest and near Hendersonville, North Carolina, in 1915. Injured trees numbered thousands and Rhoades was of the opinion that the storm had done more harm than careless logging could accomplish in many years. Ashe,[2] commenting on Rhoades' report, maintained that ice storms, or glaze storms, were by no means infrequent in the Appalachians south of Pennsylvania. Furthermore, he concluded on the basis of his extensive experience in the Southern Appalachians that ice damage to the timber was prevalent on mountain slopes between 1,200 and 4,000 feet. He observed that although a single storm might be confined to a belt with an altitudinal range of only a few hundred feet, it often extended for many miles along the mountains within that belt.

Storm of December, 1932

A severe glaze storm occurred on Saturday, December 17, 1932, over portions of western North Carolina which had experienced a similar storm 23 years before. Rain started falling late in the afternoon, freezing to the objects which it struck. One mountaineer said, "By two o'clock Sunday morning there was no sleeping at all for the noise of breaking timber." Reports of several people questioned indicate that the formation of glaze continued till 9 a.m. Sunday, when the precipitation turn to snow. The weather station at Highlands reported that practically no wind accompanied the storm.

Extent of Damage

Damage was severe in the town of Highlands and extended 14 miles to the east, 1 mile to the south, and 2 miles northwest. Much breakage was also noted

[1]Rhoades, V. H. 1918. Ice Storms in the Southern Appalachians. Monthly Weather Review 46: 373-374.

[2]Ashe, W. W. 1918. Note on the preceding. Monthly Weather Review 46:374.

along the crest of the Nantahala Mountains, and for about a mile down both slopes. Lesser injury was observed in the vicinity of Balsam Gap and Cove Creek Gap near Waynesville and at the higher elevations in the Great Craggy Mountains, northeast of Asheville. Some of these localities are widely separated, the Nantahala Mountains being 74 miles air line from the Great Craggies. Apparently the storm was confined to elevations above 3,000 feet. Although injured trees were found on practically all sites the damage seemed heavier in depressions. Not all stands were affected, but in some cases trees were broken over relatively extensive areas. Entire mountain sides were seen speckled with bright spots where branches and tops had been torn away.

Types of Injury

The type of injury varied with different sizes of trees. Larger ones suffered mainly from loss of branches and breakage of the main stems within the crown. Smaller trees of pole size were in many instances broken off below the crown, sometimes only 15 feet from the ground. Small poles and saplings were badly bent over and one month later had not regained their original positions. Comparatively open grown shade trees in the town of Highlands were badly damaged, but it was reported that pruned fruit trees escaped injury. Pole stands with even crown canopies were apparently damaged more than stands with irregular canopies.

Reaction of Species

White pine and hemlock appeared to be highly resistant to damage. Scarlet oak was a frequent victim, many red maples were severely injured, and black

Fig. 1.—Heavy damage to scarlet oak in a pole stand along roadside. Storm of December, 1932.

locust suffered heavily. White and black oak were intermediate in resistance.

Discussion

Although an occasional phenomenon, ice storms are likely to be a relatively consistent factor of region-wide importance because of the permanent damage they cause. No doubt injury from ice will help explain many of the deformed stands on slopes and ridges which formerly have been explained on other bases, such as site quality, growth habit, and drought. Ice storms may also help to account for windshake and the large amount of wormy and diseased timber of middle age found throughout certain sections. Where glaze storms repeatedly occur or in places where conditions are favorable to their occurrence possible glaze damage should be taken into account as a factor in developing systems of forest management. That this may be done, further observations are essential to determine more exactly the importance and character of ice damage as an influence upon the condition of mountain hardwood stands.

Summary

Damage by glaze storms to forests can take many forms. Some trees are broken off near the ground, others are deformed, growth is reduced by loss of branches, open wounds invite the entrance of insects and fungi.

Evidence is offered that glaze storms are relatively frequent in the Southern Appalachians and cause extensive damage.

Effects of the glaze storm of December, 1932, are described. Apparently injury was restricted to elevations over 3,000 feet. Above this elevation damage occurred in widely separated places. Trees of different sizes sustained different types of injury. Pole stands suffered more than those with irregular crown canopies.

White pine and hemlock appeared highly resistant to damage while scarlet oak and black locust suffered heavily. Other species were intermediate in resistance.

Glaze storms appear to exert a relatively consistent influence on the form of trees in the Southern Appalachians, but more observations are necessary to establish accurately their importance in forest management.

FORESTRY IN BRAZIL

By WILLIAM T. COX[1]

With most of us knowledge of South American forest conditions and their possibilities is vague and superficial. Discussion, which wells up now and then, pro and con the availability from that Continent of hardwood supplies for our North American markets has little reliable data for a basis. Mr. Cox's brief account of what he found in Brazil during his two years' so-journ should therefore be more than helpful.

NO other country in the world can match Brazil in the extent, variety and richness of her forests. In the valley of the Amazon alone virgin forests cover an area larger than all of the United States west of the Mississippi. Most of this is in Brazil.

It was my privilege to be the first forester to explore these vast "mattas" of the Amazon and of the Brazilian hinterlands. And what a joy it was to see a million square miles of untouched timber awaiting the application of silviculture—a million square miles of verdant hills and valleys covered with hardwoods and palms; still further beautified with gorgeous flowers and birds and butterflies; watered by countless unpolluted streams and occupied by primitive Indian tribes. After spending thirty years fighting in the ranks of foresters to save a remnant of our cut-over and burned-over North American forests this was indeed a pleasure. I believe I can now appreciate how Daniel Boone felt when he struck the elk and bison herds of Kentucky and how the Israelites thrilled at their first glimpse of the promised land.

My mission to South America was at the request of the Brazilian government; and the two years spent in that delightful country were occupied in traveling through the different forest regions to get first hand information, in studying the needs of the timber industry, in determining what lands should be set aside as permanent national and state forests, in finding out what might be done to encourage tree planting on the extensive "campos" or prairies of southern Brazil, in conducting a publicity campaign to awaken more widespread interest in forestry and finally to prepare a plan for the government to follow in bringing about forest conservation and in encouraging the development of forest industries along safe lines.

The forests of Brazil are more than mere forests. They are great wooded regions already producing many articles of commerce. They are now believed to contain more kinds of valuable timber and a greater variety of useful plants than can be found on any other whole continent. These forests are more accessible than any others. The mighty Amazon with its branches and their tributaries, provides twenty thousand miles of steamboat navigation, much of it suitable for ocean-going vessels. Logging is comparatively easy.

Along these splendid rivers one finds an occasional White settlement while between these as well as on the highlands there is a considerable Indian population. These people, both Whites and Indians, are masters of woodcraft. They stand ready to harvest from these forests and waters and to send out to the markets of the world the most amazing variety of products.

But there is need for capital, for enterprise and for organization of industry. In the near future when the countries of the world are recovering from their financial difficulties I am sure that the tremendous opportunities in Brazil will make a strong

[1] Organizer of the Brazilian Forest Service.

appeal and that the government and people of that progressive country will welcome the new era of development. While much interest will center on agriculture, fruit growing, stock raising, manufacturing and mining it would seem that the forests constitute one of the greatest and most promising and at the same time the least developed of all the resources.

And Brazil is taking steps to safeguard her forest wealth before it is destroyed. This is something that no other great country has ever done. The countries of Europe, North America and Asia have either gone through or are rapidly completing a process of destroying their forests with the consequent necessity of replacing them at great cost and after tremendous damage has been done. Brazil hopes, at least in large part, to avoid such economic disaster.

In a country larger than the United States we would naturally expect to find districts where tree growth is slow. In the regions of deficient and irregular rainfall trees are stunted and oftentimes the forest merges into "cerrada" or chaparral. Again it may assume the form of "catinga" or scattered, open growth. Among the four thousand and more timber trees of Brazil we would expect also to find some species that naturally are of slow growth; and there are some that take a long time to mature.

On the whole however tree growth in Brazil is rapid. Forests quickly cover denuded areas unless soil erosion has been excessive. Frequently the second growth is not inferior to the original forest in composition. It must be borne in mind also that Brazil lies mainly within the tropics; that the climate is mild with a long growing season; that the rainfall is about double that of the United States and since winds do not seem to be strong over most of the Brazilian forests evaporation is not excessive. Such conditions of course are favorable to rapid growth.

While fire has been the means used to clear or "deaden" the forest in the destructive, migratory system of agriculture long practiced in eastern Brazil great conflagrations or sweeping forest fires such as we have in the northern hemisphere are practically unknown. The heavier stands of timber are essentially safe from fire unless they are purposely prepared for burning. There are no snow slide channels on the mountain sides. Sleet storms do not occur to break the branches and wreck the forest as they do in northern climes. Forest cracks do not open up the tree trunks to fungus spores.

Fungus diseases and destructive insects, especially ants, are numerous and under warm and moist conditions develop rapidly. On the other hand a great number of the tree species are remarkably resistant to insects and disease. Some are among the most durable woods in the world. Much of this freedom from injury is accounted for by the presence in the wood and bark of protective oils and gums.

It must be said also that the balance of nature is still well maintained in most of this forest country. Armadillos and other anteaters help powerfully to keep the chief insect enemy in check. Myriads of birds seek their favorite food on leaf and branch and tree trunk. At twilight bats by the million take off to gorge on night-flying beetles.

A number of the states as well as the federal government have established small experiment stations where trees, both native and exotic, are being tried out under different conditions and for different purposes. The Jardim Botanico at Rio de Janeiro and the plantations at the Servico Florestal at Gavea near-by together constitute a splendid arboretum. At Razende between Rio and Sao Paulo is another forestry station which we were able to have enlarged and where some valuable facts should soon be ascertained. This, like the Botanic Garden and the Gavea headquarters of the Forest

Service, are federal projects. Some of the more important points where the states are conducting experiments are at Sao Paulo, Campinas and Piracicaba in Sao Paulo state; at Vicosa and Bello Horizonte in Minas Geraes; at Curytiba in Parana; at Porto Alegre in Rio Grande do Sul and at Belem in Para.

The greatest tree planting work done in Brazil, indeed one of the most interesting projects of its kind anywhere, is that carried on by the Paulista Railroad under the able direction of Dr. Navarro de Andrade. The large and fine plantations of Eucalyptus established (more than 60 species have been used) are not only profitable to the company but are proving highly valuable as demonstration plantings. The facts determined in these plantations by Dr. Andrade are going to be of immense value to thousands of planters throughout the Campo Region of southern and south-central Brazil.

It must be remembered that practically all of the coal used in Brazil is imported from England and that no oil fields have yet been developed in the country. Most of the railroads and factories therefore use wood for fuel. In fact there is an enormous consumption of fuel wood both directly and in the form of charcoal. Thus it is readily seen that the establishment of quick-growing woodlots and forest plantations adapted to the climate of the campos and resistant to ants and other insects of the region is of more than ordinary importance.

In a short article it manifestly would be impossible to describe in detail one's impressions as to the kind of silvicultural treatment likely to be called for in the many types of forest growing under different climatic conditions over so vast a country.

The crying need is for the building up of a profitable timber industry. With favorable legislation, standardization of products, agreement as to nomenclature and provision for a reasonable system of inspection this would naturally follow. For a time work in the woods will have to follow lines of least resistance. Later on more refined management will be possible. Selection cutting will have to be largely practiced in much of the more complex forest. On the other hand I saw many tracts of magnificent timber in the Amazon Valley where the bulk of the stand consisted of "merchantable species" and where logging operations would be at least as simple as in our southern hardwoods.

Forestry in Brazil for the present is largely a matter of establishing national forests and safeguarding them against destruction by uncontrolled "fire farmers." With the beginning of settlement in the Valley of the Amazon there is danger that the forests here may suffer the same fate that befell so much of the splendid original timber in eastern Brazil. There the ancient custom of girdling and firing a few acres each year, cropping the new land for a year or two and then abandoning it only to repeat the operation on a new piece of the virgin forest, has resulted in wasting tens of millions of acres of the finest timber in the world. On this account I strongly urged that huge national and state forests be established and I outlined quite a number of such projects in certain of the better timbered portions of the Amazon Basin. In such areas settlement is to be prohibited and forest destruction prevented.

In much of the forest country in Brazil "by-products" of the forest are as important as the timber itself. Probably in no other country are these so-called by-products so abundant, so varied and so valuable. I shall mention only a few of the more important of these products.

First of all comes rubber. I mention this first because it is so widely distributed and has played so important a part in the economy of Brazil. Hevea Brasiliensis, the tree from which rubber is obtained, grows throughout most of the Amazon

Basin. It seldom forms anything like pure stands but in some districts constitutes a considerable part of the forest. The tree varies in the quantity and quality of the latex (or milk) produced; some localities producing much better than others and some individual trees being far superior to the average. At Henry Ford's plantation on the Rio Tapajos which I inspected in 1930 as well as at other points where experiments were under way or contemplated the possibilities of developing a superior strain of Hevea were discussed with the managers.

It is my impression that rubber production will be considerably affected not only in plantations by the propagation of trees yielding more and better latex but by the regrowth of the former industry of gathering native, wild rubber. This industry is at low ebb now because of the low price of rubber. At present prices it cannot be maintained as an industry by itself since it cannot sustain the workers needed in the woods. With the up-building of other kindred industries—the collection of other forest products to help hold the population in the producing territory conditions might easily change and rubber might be produced throughout the Amazon Valley at very low cost and in enormous quantities.

The collection of castanha or Brazil nuts is for the present the most active industry of northern Brazil. Thousands of families earn a livelihood gathering these nuts and the somewhat similar ones known as sapucaia. It is dangerous work under present conditions for the castanha trees bear the big "cascas" in which the nuts grow at a hundred feet above the ground. When these heavy cases fall it is well to be out from under. The nut gatherers commonly work the forest for only a short distance back from the rivers, partly because of easier transportation and partly to avoid trouble with the Indians. The castanha tree occurs singly and in groups or small groves throughout most of the states of Para, Matto Grosso and Amazonas and to a lesser extent in some of the other states. The proper management of these forests would mean that the harvest of Brazil nuts, which even now is no mean industry, might be increased many fold.

Scattered through the forest and abundant in certain types and districts are innumerable palms. These greatly enhance the beauty of the forest and give a tropical touch to scenery that otherwise would suggest the temporate zone. There are hundreds of kinds of palms. Some of them are mere shrubs and vines; others like the stately burity look down on the leafy canopy that crowns the hardwood forest itself composed of giant trees. Many of these palms are useful in a high degree. They will need to be considered carefully in silvicultural practices to be applied.

The carnahuba palm produces the carnahuba wax and supports a considerable population in the work of gathering and preparing this product. The tucum palm is a fiber plant of great promise. Cordage and fish lines made of tucum fiber show astounding strength. A large territory in Maranhao, Para and Goyaz states contains this useful plant in abundance. The babassu palm, native in a vast region from north-eastern to central Brazil, produces rich oil nuts in such quantities and under such favorable conditions as to suggest an early revolutionary change in the vegetable oil industry of the world. The assahy, a slender, graceful palm bears a fruit from which is made an iced dish of attractive color and flavor and which is rapidly gaining in popularity.

Where the Parana pine forests are logged a suppressed under-story of Ilex quickly develops into a productive source of mate or "Paraguay tea." The harvesting of this crop employs a considerable part of the rural population of southern Brazil and the product seems to be in ever greater demand.

One might go on to enumerate and de-

scribe a lengthy list of other by-products—gums, oils, vegetable ivory, dyes, medicines, hides and furs of wild animals, reptile skins, fishes. But the list if anywhere complete would be altogether too long. All of these products and many more must be reckoned with in Brazilian silviculture. It is going to be a facinating task for the forester whether in the Valley of the Amazon or in central or southern Brazil to work out and apply methods of forest treatment that will give due consideration to the perpetuation of the better kinds of timber and at the same time maintain and increase the output of these other worthwhile products. One-crop forestry like one-crop agriculture is losing out in all parts of the world. Certainly diversified forestry is clearly indicated in Brazil.

During my travels in 1929, 1930 and 1931 I saw much of the beautiful mountain and valley and campo country of Brazil. I traversed the valley of the Amazon and appreciated as a forester should the magnificent forests along this mighty river and its great tributaries as well as on the uplands between them. I rejoiced to see the southern extension of these same forests on the highlands of Matto Grosso and Goyaz with their beautiful scenery, delightful climate and abundant and interesting wild life. In fact I saw just enough of that rich and wonderful country to make me envious of the future foresters of Brazil.

A MODIFIED PLOT METHOD OF TIMBER CRUISING APPLICABLE IN SOUTHERN NEW ENGLAND

By ALLEN GOODSPEED
Yale University, New Haven, Conn.

The taking of inventories on the Eli Whitney Forest at New Haven, Connecticut, has led to the adoption of a modified plot method of timber estimating, which is here described in the belief that it may prove useful elsewhere under similar conditions. The investigation demonstrates that the plot method can satisfactorily be substituted for the strip method, and that the former method can be applied by one man in such a manner as to reduce estimating time without unduly sacrificing accuracy of results.

THE Eli Whitney Forest is representative of considerable areas in the northeastern states, being composed of hardwoods usually young, but with many sharply-demarked age classes; innumerable small stands of only an acre are not uncommon while those of over 100 acres are rare.

Until 1929 a quarter-acre-plot system of estimating was used, with plots at intervals of 330 feet on lines 660 feet apart. Difficulties with this system led to its abandonment. The wide spacing of the plots made it necessary frequently to insert extra plots in order to pick up all the small stands, while their size proved unnecessarily large for the younger stands. From 1929 to 1932 a strip system of estimating was applied. A strip 33 feet wide was calipered along lines run 660 feet apart resulting in a 5 per cent estimate.[1] This system has proved quite satisfactory. Though frequently cases arose where is was necessary to run the strips at 330 foot intervals in order to sample all the stands, thus considerably increasing the cost of the work.

Evidently a method was needed in which lines could be run as close as 330 feet in order to sample all the stands and at the same time keep the cost at a minimum. To achieve the desired results a modified plot method appeared necessary. Such a method to be satisfactory should meet the following specifications:—

(a) One man must be able to do the field work.

(b) The estimate should be as accurate as that obtained in the strip method.

(c) The time and cost should be less than in the strip method.

The one-man line and plot method developed to meet the above conditions, is based on ⅛ acre circular plots. Lines are run by compass and pacing 330 feet apart with plots spaced at 165 foot intervals. The radius of each plot is measured two or three times by pacing while the trees are being tallied. As in the strip system, all trees 2 inches in diameter at breast height are recorded and measurements of increment and height are made. One man can do the work since the line running and estimating are kept separate.

The details of the method were fixed only after considerable deliberation. One-eighth acre plots were selected because their radii are so short that an estimator can see the perimeter even in dense young stands. An interval of 165 feet between plots was selected for two reasons; first, it placed the plots close enough together so that all the stands on the line were sampled, as will be shown later; second, with equal lengths of cruise line the same

[1]It is realized that a 5 per cent, or even a 10 per cent, estimate is insufficient to give extreme accuracy in the individual stands, although it may do very well for the forest as a whole. Economic considerations, however, prevent more intensive practice, the additional expense being considered unwarranted at the present time.

area was measured by both methods. Ocular estimation of diameters, with frequent checking, was adopted because of the inconvenience of first measuring a tree and then recording it, and pacing because of the impracticability of one man using a steel tape; lines being tied in at each end, discrepancies due to pacing can be distributed and error on this account minimized.

Obviously the new system fulfils condition (a) in allowing one man to do all the work. Investigation was required to determine if it fulfilled condition (b) by securing accuracy equal to that of the strip method. It was first necessary to find out if the plot method would sample all the stands and in essentially the same proportion as the strip system. This was determined as follows: From a group of map sheets representative of local conditions one was selected at random. On this sheet, aggregating 275.5 acres, parallel cruise lines were drawn 660 feet apart. Along these lines the ⅛ acre plots and the 33 foot strips were located and the area of plot and strip estimate in each stand computed. That the two methods are practically identical can be readily seen by reference to Table 1.

TABLE 1

TOTAL AREA ESTIMATED IN EACH STAND BY PLOT AND STRIP METHODS

Stand	Plot	Strip	Stand	Plot	Strip
	Acres			Acres	
a	.25	.30	l	.25	.15
b	.50	.45	m	.13	.11
c	.63	.48	n	.00	.08
d	1.00	1.11	o	.50	.53
e	.88	.83	p	.88	.46
f	.38	.37	q	.25	.27
g	.50	.54	r	.50	.49
h	1.50	1.59	s	.13	.11
i	3.25	3.48	t	1.88	2.32
j	.13	.10	Total[1]	14.67	14.79
k	1.13	1.02			

[1]Slight discrepancy between area totals was caused by placing first plot on each line equidistant from the initial point of the line rather than equidistant from the last plot on the previous line.

The next step in testing the plot method was to learn whether it possessed any inherent impracticability that would make it impossible to secure, within each stand, results of an accuracy at least as high as that obtained by the strip system. In other words, if applied with equal care would not essentially similar results be obtained by either method and could not such differences as might be observed be attributed to variation in sampling rather than to error peculiar to the system used. The following procedure was used in attacking this problem.

In each of three age classes, (21-40, 41-60, and 61-80 years), an estimate was made by each method, and three pairs of comparable samples obtained, a single sample consisting of twenty-five ⅛ acre units. In order to reduce the source of difference between comparable samples to variation in sampling alone, each method was applied with equal precision, using a two-man crew. The plot estimate was made first, leaving at the center of each plot a numbered stake, and keeping each plot tally separate from all others. Following this a continuous strip estimate was run over the same line, the previously set stakes serving to insure alignment and also to break the estimate up into 165 foot or ⅛ acre units, the tally on each of which was kept separately.

Three pairs of closely comparable samples were thus obtained, as nearly identical as the two methods permitted. In fact the strips and the plots overlapped to the extent that 44.5 per cent of the area in the strips was common to the plots. Variation in sampling was thus confined to the 55.5 per cent of each sample foreign to the other.

In the office the following data were computed for each sample:

(a) The total board foot and cubic foot volume of each sample and the average per ⅛ acre unit. Board foot volume was computed for the trees 8 inches and over in diameter breast high

and cubic foot volume for all trees 2 inches and over.

(b) The standard deviation of the units in each sample according to the formula[2] $S = \pm\sqrt{\frac{\Sigma d^2}{n}}$

(c) The standard deviation of the average for each sample according to the formula $Sa = \pm\frac{S}{\sqrt{n}}$

(d) The standard deviation of the difference of the averages, according to the formula $S \times y = \pm\sqrt{\frac{S\times^2}{n\times} + \frac{Sy^2}{ny}}$

These data are presented in Table 2 and lead to several definite conclusions.

The average volumes of comparable samples are reasonably similar, the greatest percentage variation being found in the board foot volumes for the 21-40 year age class. It is to be expected that the largest variations should occur in this young age class since it contains comparatively few trees big enough for lumber, so that a difference between samples of only one or two large trees made a considerable difference in total volume. Had the samples been larger the probability is that this variation would not have been so pronounced. A comparison of cubic foot volume in this same age class shows no such large irregularity. Here the bulk of the volume is made up of trees 2-7 inches in diameter breast high which comprise the main stand and the effect of the occasional large tree on total volume is greatly diminished.

Careful inspection of the data fails to show any apparent correlation between estimating method and high or low values in the series of comparable samples. The presence of such correlation would show bias on the part of one of the methods.

The standard deviations of comparable samples are in close agreement, indicating that the dispersion within the samples is similar. An equally close agreement is obtained for the standard deviation of the average in comparable samples. This indicates that the average volumes by the two methods of estimating may be equally close to the true average for the universe in which the samples were taken.

The standard deviation of the difference of the averages can be used to determine whether the difference between two com-

TABLE 2

COMPARATIVE DATA ON THREE PAIRS OF ESTIMATE SAMPLES CONTAINING TWENTY-FIVE 1/8 ACRE UNITS EACH

Age class years	Plot estimate: Total volume	Plot estimate: Average volume per 1/8 acre	Plot estimate: S	Plot estimate: Sa	Strip estimate: Total volume	Strip estimate: Average volume per 1/8 acre	Strip estimate: S	Strip estimate: Sa	Difference of the averages	Sxy
				Board feet						
21-40	1,895	76	± 81.3	±16.3	2,425	97	± 80.6	±16.1	21	±23
41-60	10,765	431	±210.4	±42.1	11,380	455	±206.6	±41.3	24	±59
61-80	16,495	660	±356.4	±71.3	14,515	581	±320.5	±64.1	79	±96
				Cubic feet						
21-40	3,005.3	120.2	± 36.6	± 7.3	2,706.8	108.3	± 26.0	± 5.2	12	± 9
41-60	4,064.2	162.6	± 44.5	± 8.9	4,468.7	178.7	± 53.0	±10.6	16	±14
61-80	4,468.7	178.7	± 68.8	±13.8	4,087.0	163.5	± 62.2	±12.4	15	±19

[2]This formula and the two following are taken from Wright, W. G., 1925. Statistical Methods in Forest Investigative Work, Bull. 77 Forestry Branch, Dept. of Interior Canada. p. 36.

parable means is significant or may be attributed to variation in sampling. If the difference between the averages does not exceed three times its standard deviation then this difference usually is not considered significant. Values for this measure are shown in the last column in Table 2 and indicate that any difference between averages of comparable samples can be accounted for by variation in sampling. The same conclusion was reached after analyzing the data according to Fisher's[3] methods for small samples.

Results of the analyses indicate that the two methods, when applied with equal precision, give essentially similar and equally reliable results.

With equality of accuracy in the two methods established, a final test was undertaken to determine the effect of substituting one man for a two-man crew in the execution of the plot method, and to secure time data on the two methods. The test consisted of running, in each of five different age classes in the hardwood type, a quarter mile of strip estimate with a two-man crew, followed after an interval of a week or more and in a different order of age classes by a quarter mile of one-man plot estimate. The point of departure in a stand was the same for both methods but beyond that each cruise was run independently. The controlling conditions during the test were those of actual practice.

Table 2 indicates the variation in volume by the two methods that can be attributed purely to sampling. In Table 3 the variation in volume is attributable to sampling and to error arising from the less precise methods of the one-man plot estimate; however, it is evident that the variation in Table 3 is not more than may be attributed to sampling alone.

Columns 4 and 7 of Table 3 show the man-hours spent in making each estimate. In all but the youngest age class it took nearly one half again as long to run the strip as the plot estimate. In the 1-20 year age class the strip method took twice as long as the plot method. A marked saving of time in favor of the plot method is shown.

TABLE 3

COMPARATIVE DATA FROM PLOT AND STRIP ESTIMATE ON QUARTER-MILE SECTIONS OF CRUISE LINE

Age class years	Board feet	Cordwood in small trees and tops	Man hours	Board feet	Cordwood in small trees and tops	Man hours
1 - 20	330	5.5	2.05	525	4.0	3.97
21 - 40	1,759	9.2	1.88	1,743	8.0	2.87
41 - 60	2,950	7.6	1.72	2,658	7.5	2.60
61 - 80	5,009	8.5	1.95	5,124	8.4	3.10
Uneven	4,377	5.2	1.78	3,660	5.6	2.60
Total	14,425	36.0	9.38	13.710	33.5	15.14

[3]Fisher, R. A., 1930. Statistical Methods for Research Workers.

THE PLACE OF GAME MANAGEMENT IN NEW ENGLAND FORESTRY

By J. PAUL MILLER

U. S. Biological Survey, Amherst, Mass.

In this article the author takes us into the more intimate phases and possibilities of a given condition or locality in its relation to given species. This is vitally essential and fundamental in the development of forest-game plans. The suggested methods for considering the utilization and revenue phases of game in relation to the private landowner appear to offer a very practical basis for satisfactory negotiations between him and the hunter or sportsman.

GAME management and forestry are not independent projects that differ in their objectives and necessitate different or conflicting procedures to attain their ends. On the contrary they sprang from a common source, and various forestry practices in vogue at this time no doubt originated indirectly in connection with the development of game management in Europe. Be that as it may, the forester today is interested in all possibilities of improving the stands under his care and of finding new sources of income so as to put the projects on a paying basis. Game management may be made to aid in this respect. Sportsmen apparently are interested, not so much in the lumber, as in the game production of the forest; what they want is more game and it is assumed that they are willing to pay a reasonable price for it. A most promising feature of the situation is that apparently the objectives of both the forester and the sportsman may be attainable together.

The principal arguments for taking up game management in connection with forestry are economic, but the practicability of obtaining significant financial returns is something that remains to be demonstrated in this country. Real information on many phases of forest game management is sadly lacking, and the plea of this paper is for investigation adequate to obtaining it. There is not enough evidence, for instance, as to the revenue that forest landowners can expect from game. Insufficient information is available regarding the kind or quantity of game that can be produced, and what the cost will be to produce it. Furthermore, it is yet largely to be determined to what extent game or hunting rights can be marketed after they have been produced. Therefore, although we may be optimistic regarding the possibilities of game management in forests, forestry and sporting interests both will be better off if there is moderation in claims during the experimental periods and until definite facts are available.

The term "game" may be construed in this connection to include both animals with a sporting value and fur-bearers. As to what makes a sporting animal, it may be stated for instance that a bird should have the following characteristics to qualify as an object of sport: the species should be prolific; the young should be of the precocial type (i. e., ready to travel when hatched); and the species must be hardy, able to withstand the climatic conditions of the region concerned. The birds should be palatable, should be large enough to be of use as individuals, so the killing of large numbers before any use can be made of them would not be necessary. The birds should be gamy and strong, swift fliers, and considering American preferences in hunting, it is desirable that they lie well to dogs.

Mammals, on the other hand, have somewhat different standards of value. For instance, they need not be edible if the fur is of sufficient worth, but if certain animals can be used for both purposes, they should be given preference. Some species occupy a doubtful economic position and while having value as game or fur-bearers may often be rated as "vermin." Furthermore, some species through their feeding habits may reduce the game production of an area either by preying directly upon other species or by crowding them out by competing with them for food unless the supply is superabundant.

As to whether a certain animal has possibilities for producing revenue and whether it would be advisable to encourage increase of the species, much depends on local conditions. In some instances game may be a menace rather than an asset, and because of the many interests to be considered in producing the most satisfactory and profitable results from game on a forested area, it appears necessary that game be managed.

Game management proceeds along either chiefly artificial or chiefly natural lines. In the artificial system, the animals are raised in pens and then liberated for restocking purposes. This method has no part in practical forest game management. In the more natural system, the game is assisted especially by improving cover and food supplies and by giving it special protection. This method seems to have possibilities in connection with forestry.

In improving the natural cover and food supply of an area, good silvicultural methods must of course be practiced, but there is ample reason for conducting these operations with both the welfare of game as well as of the trees in mind. It is realized that the primary purpose of forestry today is the production of merchantable timber, but it is also recognized that there is a growing demand that these forests be administered in such a way as to produce not only lumber but recreation and sport. New England forests have great potential recreational values because of their accessibility to large centers of population. The possibilities as to revenue on this account will remain speculative, however, until such time as the factors upon which recreation depends can be guaranteed, produced, and marketed in a businesslike manner. Because of this situation there bids fair to develop two distinct practices in the handling of forested areas. One, primarily forestry, is the production of trees for lumber which at present is so unprofitable that only the government, state or federal, can afford to go into it, and the other, primarily game management, anticipates revenue from recreational and sporting uses and considers the application of silvicultural practices for the production of timber as incidental. It will undoubtedly be to the advantage of both interests to work together, but to do this certain fundamental principles relative to both the production of trees and game must be given consideration and coördinated whenever possible.

Among circumstances that must be borne in mind when considering the welfare of game in forest areas is this, that very few if any animals restrict their year-round range to a single type of habitat; in most cases several are used. The animals may frequent a certain type of cover periodically but in addition they make use of various other ecological types in search o ood, shelter nesting sites, or other necessities. The use of various types of cover is not merely a matter of choice but is essential. Another point to be considered is that the range of the animal is affected by these requirements. It must travel the distances necessary to find the requisites for its life cycle and will persist only where they can be found within a reasonable distance. Also, animals tend to protect units of ranges against invasion by their own kind as

well as by other species and the limitations of suitable coverts therefore control the numbers a given range can support. Because of these demands, large areas of uniform environment will accommodate only a limited number of individuals or species. Diversification is a necessity for maximum production of wild life.

A forester naturally feels that the major use of the land is growing of forest crops but there is no reason for considering game other than a forest crop. In general silvicultural practices have a favorable effect upon the game population and in some instances need to be only slightly altered to accomplish not only the desired effect on the forest but also to produce a satisfactory wild life population.

The effect on game of numerous phases of silvicultural practices under various conditions is not known but it appears logical to assume that in general a forest of varying age classes and mixed species broken up into small units is better for game than large areas of single species.

Marginal areas such as develop around the borders of clearings, fire lanes, and cuttings are essential to the abundance of game. Sunlight and conditions suitable for germination prevail so that food and cover are plentiful. In addition these areas offer necessary types of habitat in close proximity, which is not the case in extensive mature, and especially dense, stands.

Fire protective measures such as the maintenance of fire lanes and of a water supply, the piling of trimmings and brush, in addition to providing the necessary fire protection, offer better food and shelter conditions for certain species of game.

The practice of weeding in replanted cutover hardwood areas improves conditions for game, as well as liberating the trees, since such a practice tends to increase sucker and sprout growth, thereby offering additional food for browsing animals.

The thinning of stands by the removal of trees as the canopy tends to close, allows the sun to penetrate to the ground and permits young growth to exist where otherwise, in the case of conifers, there would be only a thick carpet of needles largely barren so far as the interests of most kinds of wild life are concerned.

In the case of clear cuttings, game would benefit most if the areas thus operated on were limited in extent.

A margin of trees should be left standing along streams; this shades the stream, tends to check runoff and erosion, and provides a windbreak. Occasionally circumstances are such that beavers may be introduced and allowed to build dams, which serve to maintain a water supply during the drier months, raise the water-table, and check runoff and erosion, in addition to serving as homes for these valuable fur-bearers. Ponds and streams are important to game as well as to the forests, and their improvement and maintenance benefit all forms of wild life. Generally also they aid in fire protection.

As to kinds of game available for management in forested areas of New England, we must say with reference to the popular ruffed grouse or partridge that at present so little is known about the requirements of the species that no promises can be made as to what may be expected of the bird under management. The more or less periodic rises and drops in numbers of this bird may make management impracticable. Conditions may be improved for the woodcock and for waterfowl, as where beavers are allowed to construct dams and flood waste bottom lands, but usually this will not be in connection with forestry projects.

Quail are so dependent on cultivation as not to enter extensively into plans for forest-game management; this remark applies almost equally to the ring-necked pheasant. At present, therefore, the

ruffed grouse or partridge seems to be the only bird of promise for management in New England and until the conditions necessary for its well-being are better understood there is little assurance of successfully commercializing the hunting of this species.

Mammals offer more possibilities for forest-game management, as, including fur-bearers, there are available for consideration: deer, rabbits, squirrels, and the bear, racoon, skunk, muskrat, beaver, mink, fox, otter, opossum, fisher and marten and others. Not all of these could be maintained on a limited tract, but usually habitats suitable to several species would be available on any large area.

Disease, predators, food supply, climatic conditions, associated species, public sentiment, and other factors bear upon the advisability of increasing the numbers of any species present or of introducing others. Difficult as the intricate relationships of wild life are to understand, they are even more difficult to forecast, and interference with them often brings to light unforeseen problems.

Even when all conditions are favorable, there remains the problem of how to realize a revenue from wild life after the supply is increased sufficiently to warrant disposal of the surplus. The fur-bearers may readily be trapped, but if outside trappers are employed, careful check upon their operations will be necessary, and some provision for taking only prime adult animals should be enforced. The harvesting of game produced for sporting purposes presents still more perplexing difficulties. In connection with a large forest project, questions of administration are paramount. The head of game that may safely be taken must be accurately estimated, permits must be issued for the taking of that number and no more, the bags obtained must be checked, and careful records kept of all operations, as well as of receipts and disbursements.

Game management may be undertaken by organizations in connection with private holdings of forest lands, and in such a case reconciling the interests of all concerned may be a major problem. Any solution must take into consideration the fact that the landowner has the privilege of deciding whether or not he wants to sell the right to hunt on any or all of his property; in other words the landowner is in control, and his rights must be fully recognized. It is assumed that the sportsman will be willing to pay for the privilege of going on managed land if the fee is reasonable and he knows where to apply for permission. Probably the principal objection the sportsman has had in the past is that he did not know where to obtain sanction and he had no assurance that he would be assessed a reasonable amount.

A suggested plan for forest-game management by organized groups calls for the establishment of suitable areas; counties are usually too large, but towns or townships might be satisfactory. Any landowner within this unit could designate tracts on which he is willing to allow hunting. The permits should be obtainable from the town clerk or some equally accessible person, and should be of several kinds, some for a day's privilege, some for the season, and, if desirable, there could be a distinction made as to residents or non-residents. Out of the fees collected, the cost of printing posters and permits should be deducted as well as other necessary expenses. The posters should be furnished the landowner free of cost and should state that the holders of permits were *invited* to hunt on the property enclosed by the posters. The number of acres in the plot and the owner's name also should appear on the poster. Some method of ascertaining that the land actually is properly posted would be necessary.

After the expenses for the season have been deducted, the remainder should be divided among the landholders according

to the productive acreage allotted for hunting purposes. This plan depends laregly on coöperation, but it has the advantage of remunerating only those who will coöperate. The town or other area having the best game covers and the most game will be able to collect the most for hunting rights. If properly handled, it will be possible to determine how intensively the tracts are hunted and also to regulate to some degree the amount of hunting. The returns that may be realized from such a management project may be limited, but the plan gives the owner of a small tract the opportunity to sell his proportionate share of hunting privileges to the sportsman. The sportsman in turn will be assured of a just and uniform fee, and he will have the comforting knowledge that he is in no way imposing on the owners of the property on which he hunts. Since the game itself is the property of the state, it should be clearly understood that landowners are not selling the game; they are merely selling the privilge to hunt on their property. The more game on the property, however, the more the privilege will be worth; and game management will be rewarded in proportion to its efficiency.

Many of these suggestions apply also to large projects primarily established for reforestation, but the feasibility of carrying on game management will depend on satisfactory adjustment of the necessary methods with sound forestry practice, as well as upon production of revenue large enough to pay all added expenses chargeable to game management and to yield a profit besides. The outlook for harmonizing game and forest management so as to produce the desired results is hopeful, but as noted in the beginning, the undertaking is still experimental; there is need for further investigation of almost every phase of it, and exaggerated expectations and premature claims of success should be guarded against.

SCHOOL FORESTS IN MICHIGAN

By R. F. KROODSMA

Extension Forester, Michigan State College

The school forest, as defined in Michigan, means a tract of forest land owned, controlled and cared for by a school or several schools, such as would comprise a school district. The usefulness of such a forest is one important means of forestry publicity, as set forth in this article.

IT is a recognized fact that any public enterprise can succeed only to the extent to which it is backed by the people. This is true whether it be support for the traffic laws, the 18th amendment or forestry and conservation. How to secure the interest of the public at large in forestry has long puzzled the minds of the best thinkers. All sorts of devices are tried in order to secure the interest of the general public. We have American Forest Week and Arbor Day. In Michigan, a great deal of money has been spent annually for wild life displays and forestry exhibits at the various fairs. We have used letters and motion pictures. Volumes of newspaper publicity have been written and the countryside has been plastered with slogans and signs. All of these various agencies have been helpful, but after all is said and done there remains a great class of people whom nothing seems to reach. In a state like Michigan where more than 50 per cent of the land area is classed as forest land, all possible support for conservation is needed.

This was particularly the case in the northern peninsula of Michigan—an area of 11,000,000 acres and in fact almost a state in itself. Except for a small element, there is in that section of Michigan an apathetic attitude toward the forest. This is due to the following conditions:

First: The Upper Peninsula is still in the pioneering or land clearing stage. Second: Most of the remaining commercial stands of timber are located in that section, thus giving rise to the state of mind that "Where there is plenty, why be careful." Third: There is a large foreign element, working part time in the mines and logging camps who in spare time are carving out small farms on the better types of cut-over lands. The attitude of this class is "get rid of the trees by burning or any other way." There are actually farmers in the upper peninsula who have carried this idea so far that they are forced to secure fuel elsewhere than from their own lands. Fourth: Most of the privately-owned land is in very large holdings or has reverted to the state for taxes.

Realizing that due to these factors and the general frame of mind of the public in general, there would be small chance of carrying out the ordinary activities of extension forestry work, it became evident that something with a popular appeal would have to be used instead. This resulted in the idea of the school forest.

The school forest, as defined in Michigan, means a tract of forest land owned, controlled and cared for by a school or several schools, such as would comprise a school district. At the time the first school forests were established in 1930, there was no legal method of acquiring the necessary land by purchase. This did not prove to be an obstacle, however, as many of the fore-mentioned land-owners were only too glad to coöperate by either deeding over the land direct or leasing for a long period of years. The first school forests were established through the coöperation of the agricultural agents.

who in turn made the local contacts and secured the backing of the various school authorities. As a result of this initial effort twelve school forests were secured, scattered from Gogebic County in the extreme west portion of the upper peninsula to Luce County in the east. Donations of land ranging from 40 to 160 acres were secured from the Ford Motor Company, Cleveland Cliffs Iron Company, Menominee Land and Iron Company, Charcoal Iron Company, and from private individuals. Enough free planting stock for 5 acres on each forest was furnished by the State Conservation Department and Michigan State College. The trees were, in most instances, planted under the supervision of the state extension forester. Following the planting of the trees which occupied the first half of May, suitable dedication exercises were arranged for each school forest. School was usually dismissed for the day and the dedication was made a community affair—the parents as well as children turning out for the exercises. Previous to the dedications, all of the pupils signed a covenant or compact promising to care for their forest. This compact remained in the possession of the school as a memento.

The dedications were made impressive and were designed to include as many different agencies as possible as will be noted from the following program:

1. Music by school orchestra or vocal singing.
2. Presentation of deed. Donor of land or representative.
3. Acceptance of deed—member of school board.
4. Formal presentation of trees—Extension Forester, Michigan State College.
5. Conservation and the school forest—Assistant State Forester.
6. Interest of the Forest Service—Supervisor, Hiawatha National Forest.
7. Remarks—representative, School of Forestry, University of Michigan.
8. Purpose of school forests—Assistant County Agent Leader, Michigan State College.
9. Reading of covenant—local school superintendent.
10. Acceptance by pupils.
11. Dedication of forest—Dean of Agriculture, Michigan State College, and Secretary, Upper Peninsula Development Bureau.
12. Charging pupils with duties of caring for forest—Assistant State Club Leader, Michigan State College.
13. Planting of memorial trees by various local people.
14. Music.

One of the important features of the forest is a suitable sign. Michigan has used one of galvanized material 4 x 6 feet furnished through the courtesy of the Upper Peninsula Development Bureau. The inscription bears the name of the school forest, the donor of the land, the date established, and at the bottom the slogan "Have Youth and Trees Grow up Together." It might well be stated in passing that galvanized iron is rather a poor substitute for wood as after three seasons, the paint has weathered badly. A wooden sign would appear to be preferable.

The school forest idea went over so well in 1930 that the following year nine new forests were added to those already established and the following year four more, making a total for the upper peninsula of 25 school forests. The same general scheme was carried out each year in establishing new forests.

In 1931 the Michigan legislature passed a bill called the municipal or community forest act which legalized the school forest, permitting the expenditure of money for such uses. The purpose of the act is stated as follows: "An act to provide for the establishment and maintenance of county, township, city, village and school district forests; to provide for commissions to supervise such work; to provide for the sale of state lands for such purposes; and to provide a limitation on the

expense of such work."

The northern half of the lower peninsula also contains a great deal of the forest land of the state. Ownership and conditions are, however, different than in the upper peninsula. The commercial forests have largely been cut and much of the land has reverted to the state. Also there are few large private holdings. This made it difficult to promote the school forest in the lower peninsula. However, as a result of the above mentioned legislation, the big problem of land was solved and in 1932 eleven school forests were established in the lower peninsula. Thirteen more were established in 1933 making a total of 24 in lower Michigan or 49 for the entire state. It should be mentioned in this connection that the Michigan Lands Division has aided a great deal by deeding over forties for the actual cost of transfer.

The school forest project divides itself roughly into seven steps:

1. Selling of the idea to the school.
2. Securing of necessary land.
3. Survey to determine proper species and method of planting.
4. Securing of planting stock.
5. Planting of trees.
6. Dedication (optional).
7. Fall check-up for results.

All of these factors have a bearing on the success or failure of the school forest. The most important features, however, are the kind of land secured and the method and thoroughness of planting. A school forest should consist of at least 40 acres of land, although smaller parcels can be used if no other is available. From the standpoint of accessibility and advertising value it should be located on a highway—preferably a trunk highway.

A forty which has some variety such as a stream, a ravine, a hill or a lake is also to be preferred. Such variations offer different planting sites, often require different species, and are advantageous from a biological or botanical standpoint. Distance is also somewhat of a factor. The closer the forest to the school, the better. In Michigan, nine miles is the greatest distance between school and forest. With modern transportation this is not too far. It is well to have the planting site picked by a technical man as mistakes are easily made. This spring the writer was called upon to look over a site that had been practically decided upon with the necessary papers all ready to sign. Upon examination it proved most undesirable. The forty lay back from the road, it was excessively rough, covered with dense sprout growth of oak, red osier, sassafras, popple and briers, and was to say the least a tough planting proposition. Such a forty is very discouraging to boys and girls who have to do the planting. The question might be raised as to whether a forty should be a planting forty or whether it should have second growth. Second growth is not objectionable, but to really hold interest there should be some planting area. It is realized, of course, that planting is a very small part of forestry, nevertheless, people in general and children in particular take more interest where trees are planted and the growth can be watched from year to year.

A second most important point in the program is the planting of the trees. This too should be in charge of a technical man. Nothing kills the school forest so quickly as a poor survival. The writer well remembers one school forest which was left to a county agent to handle and which was practically 100 per cent failure. It took about two years to revive interest.

The number of trees which should be planted each year depends upon several factors such as size of the school, character of the planting site and amount of supervisory help available. In Michigan, not more than five acres per year at the most is recommended and from the stand-

point of educational value two or three acres is just as good as five. Five acres per year spreads the program over eight years altogether and allows the planting to be done by the older pupils each year. In the eight years time, eight different aged groups will have had a chance to participate. In good planting with ploughed furrows available 15 to 20 boys will plant 5,000 trees a day easily. In spot planting, 60 boys and girls will have a hard job planting the same amount in a day's time. With plenty of supervision and good planting, as many as 60 can be handled at one time. Boys are boys, however, and with hard planting there is a tendency to slight the job, go for drinks real often, or put 2 to 6 or more trees in one hole, etc. Therefore, under such conditions it is much more advisable to plant just 2,000 trees per day, have the job done right and the boys and girls willing to repeat the following year.

Wherever possible trees are planted in shallow furrows. This makes for a better spacing, makes easier planting, and gives better survival. An attempt is made to plant at least two species in mixture on each forest. This divides the risk and gives the boys and girls a chance to make comparisons.

By using *Pinus strobus* (white pine), *Pinus resinosa* (red pine) and *Picea glauca* (white spruce) either singly or in mixture, practically every planting site is covered. Where there is a bad ribes situation, or a wet site or hardwood growth, white spruce is used to good advantage. Under other conditions it is often possible to mix all three.

As a result of the establishment of school forests there is an increasing interest in community forests. Since the first of the year at least three forests of 120, 160 and 330 acres, respectively, have been established by cities in the lower peninsula. On one of these forests 8,000 trees were planted by 65 business men in about 4 hours. On the second, 40 acres were planted in two days by 27 men. On the third, the town unemployed was used to make the initial planting. There are in Michigan a total of 22 community forests in addition to the school forests.

The question might be raised as to the

Fig. 1.—Presentation of trees.

success of the school forests. With but few exceptions, results have been all that could be desired. The first forests were established in very dry years, yet there has been as high as 90 per cent survival. So far as the educational value goes, this is even more pronounced. Many of the forests have been scouted for ribes, and protected from blister rust. Most of the schools spend a day or several days in preparing the planting site such as cutting and burning brush, removing old logs, etc. Fire lines have been ploughed and records are kept. In the fall check-up, a committee of boys checks results with the extension forester and this committee reports back to the school. Many of the first plantings are now knee high and this tends to intensify the interest. Four-H Ranger Stations (forestry clubs) are often organized in connection with the school forest and in this way a regular program of forestry work is carried on during the summer. Marquette County has nine established forests leaving only one or two sections which have not been reached. Newaygo County also has nine forests, and the county agent reports that the attitude of the general public has changed decidedly since the various school and community forests have been started. This influence cannot fail to be of help to state conservation in general.

A school forest is the means of teaching in the best way possible the valuable lesson of conservation in all of its branches. It can at the same time serve as an outdoor laboratory for the natural sciences. In the course of time it will return a revenue to the school. Above all, however, is the great value it has in reaching people otherwise not reachable. A person cannot travel the main highways of the upper peninsula without seeing "School Forest" "Have Youth and Trees Grow Up Together." By interesting the boys and girls the interest of the parents is automatically gained. A glance at the records of 1930 show an attendance of 2,203 at 14 school forest dedications. The intrinsic value (for the present at least) is secondary to the value of creating a forest consciousness among the general public.

FORESTRY AND LAND USE IN THE CENTRAL STATES

By RALPH K. DAY

Central States Forest Experiment Station

There is a surprisingly general misconception, even among foresters, that forestry in the Central States constitutes little more than the proper management of farmwoods. The dominance of agriculture throughout the "Corn Belt" and the fact that our main transcontinental railroads and highways traverse this rich agricultural section have created the impression that the terms "Corn Belt" and "Central States" are synonymous. The author here interestingly considers the economic, silvicultural and utilization problems peculiar to the farmwoods of this region.

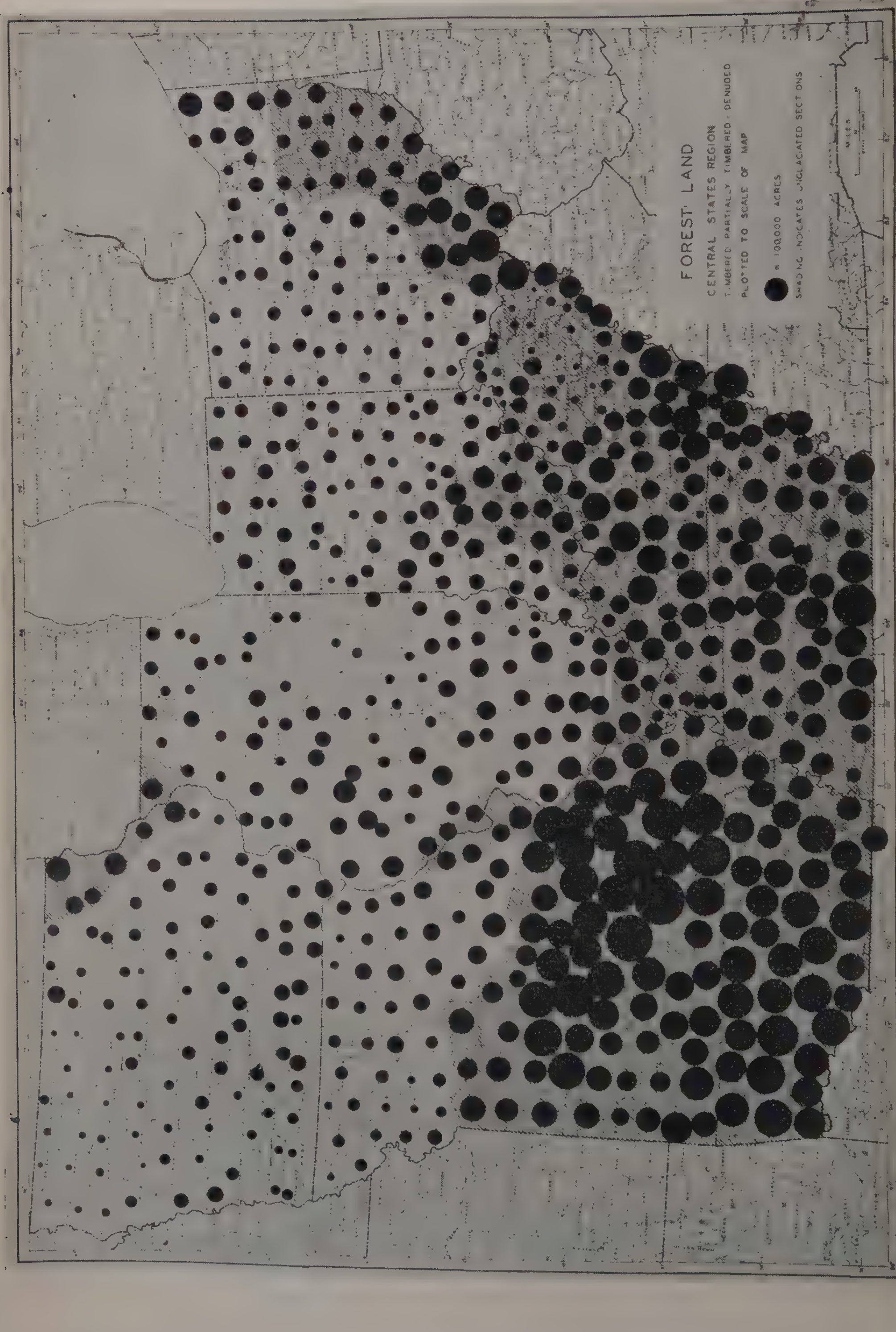
THE "Corn Belt" constitutes but little over half the land area of the Central States and its fertile, glacial soils are sharply defined from the rough, less fertile and extensively timbered lands to the south. Over 25 per cent of the total land area of the region is in forest or farmwoods and nearly 37 per cent of the original forest area still remains in some stage of tree growth. Figure 1 and Table 1 present graphically and statistically some data concerning the extent of the forests of the region.

The region, principally that portion south of the Corn Belt, contains nearly one-fourth of the total stand of hardwood timber in the United States. The 53,935,000 acres of forest and farm woodland in the Central States constitute over 15 per cent of the total forest area east of the Great Plains and nearly 11 per cent of the total for the Nation. Nearly 32 per cent of the annual hardwood timber and approximately 14 per cent of the total timber production of the country come from the Central States, and the annual value of the lumber cut of the region is normally in excess of $175,000,000. The extent to which timber production should and could enter into the future economic development of the region is apparent when it is realized that over 25 per cent of the national timber production is consumed within these states. The farmers of the five Corn Belt states alone in normal years expend over $34,000,000 for lumber used in farm structures. The freight bill for the softwood lumber imported from the South and West by the industries of these same five states is in excess of $100,000,000 annually. Obviously, the forest resources of the Central States play an important rôle in the forestry program of the Nation, and their influence is and will continue to be a vital factor in the economic structure of the region.

Figure 1 strikingly indicates the extent of the agricultural Corn Belt and the heavily timbered, unglaciated section. Both of these sections have distinct forest problems, and overlapping each is a third set of problems relating to proper land use of large areas of marginal land. In order that the magnitude and region-wide scope of these problems may be appreciated, those of greatest importance will be briefly considered. Three broad groups have been recognized to which the individual problems may be assigned. These are: Management of Upland Forests, Forestry and the Land Use Problem, and Farm Forestry and its Future.

Management of Upland Forests

The forests and woodlands of the unglaciated sections, aggregating 38,000,000 acres, constitute about 70 per cent of the total forest area of the region. Objectives of good forest management on these areas involve far more than timber production. On millions of acres, a cover of tree growth is essential for erosion


FOREST LAND
CENTRAL STATES REGION
PLOTTED TO SCALE OF MAP
= 100,000 ACRES

and streamflow control. A permanent forestry program for this region is of national importance as a vital factor in flood control on the Mississippi and Ohio river watersheds. Recent studies indicate that forests are a more potent influence in the regulation of streamflow than had been hitherto appreciated. Dr. J. T. Auten of the Central States Forest Experiment Station, in comparing forest and field soils, has shown conclusively that the greatly increased porosity and water absorptive capacity of forest soils, is not limited to the surface litter and humus, but extends at least to a depth of nine inches. There are also public interests involved in the wild life and recreational resources which should receive consideration in the development of such a program.

The fundamental forest problem in these unglaciated sections is land ownership, for without stable ownership, none of these objectives can be made effective. Industrial forestry in the upland forests of the region does not exist on any considerable scale, and probably will not in the near future. The principal reason for this is lack of growing stock. The woods have been so badly depleted through continuous cutting and fire that there usually remains only a small fraction of the normal growing stock. Timberland owners as a class are anxious to dispose of their cut-over lands. There appears, consequently, to be little prospect of voluntary management on many of these areas, and effective compulsory regulation would be most difficult to enforce at the present time. In fact, the devastation and deterioration which are taking place on many of these lands indicate that they may ultimately be thrown back on the public as tax delinquent and in a worthless, eroding condition, a public liability and responsibility possibly as great as the present problem of submarginal agricultural land. Public acquisition of extensive areas appears to offer the most logical solution of this problem of stable ownership as applied to these private timber holdings.

It is obvious that any program of extensive acquisition for public forests will be largely confined, through financial limitations alone, to the heavier timbered sections and to those constituting serious erosion and watershed problems. Consequently the land use problems which are being created in the extensive submarginal agricultural areas must receive separate attention. The rapidity of land abandonment and increase in tax delinquency in these areas are already forcing many taxing units into bankruptcy.

One of the most unfortunate situations adversely affecting the advance of sus-

TABLE 1

ORIGINAL AND PRESENT AREAS OF FOREST LAND CENTRAL STATES REGION

State	Original forest area acres[1]	Present forest area	
		Acres	Per cent of original forest
Ohio	25,600,000	4,650,000	18.2
Indiana	19,840,000	3,440,000	17.3
Illinois	16,000,000	3,200,000	20.0
Iowa	5,120,000	2,360,000	46.1
Missouri	32,000,000	16,285,000	50.9
Arkansas[2]	14,400,000	10,000,000	69.4
Kentucky[3]	16,680,000	6,500,000	39.0
Tennessee[3]	15,710,000	7,500,000	47.7
Total	145,350,000	53,935,000	37.1

[1]Central States Forest Experiment Station—Unpublished compilation made in connection with a special report to the Timber Conservation Board. Columbus, Ohio, 1932.
[2]Estimated area north of Arkansas River and 35th parallel.
[3]Estimated area west of Cumberland Plateau.

tained yield forest management in these sections is the gradual disappearance of the permanent mills and the proportional increase of portable sawmills. The reestablishment of the permanent industries will require the combined efforts of both public and private interests. The day of the big mill is gone, but there is every reason to expect that local wood-using communities can be built up with state or national forests as nuclei. Public forests should be managed to produce materials of a quality and quantity calculated to stimulate the development of local industries and to create a demand for the products of the private holdings in the vicinity.

The silvicultural and protection problems in the unglaciated sections are of vital importance to successful forest management. The reestablishment of a growing stock and the prevention of forest fires are the most important of these at the present time. Another problem requiring attention is that of improved cutting practices. Probably in no other timbered section of the country have the owners shown such a lack of foresight in the utilization of their timber resources, not only with regard to the possibilities of a future crop, but with respect to the present. Young thrifty trees are removed for low-grade ties, mine props, car blocking, and other cheap products when a few years' additional growth would permit the manufacture of high-grade materials. An important factor influencing the margin of profit, and one that has been largely overlooked, exists in the cutting of low stumps and the use of top and limbs for mine props, car blocking, and fuel. Such improved utilization may increase the yield as much as one thousand feet per acre.

Indiscriminate lumbering followed by fire is lowering the productive capacity of the sites. This is being brought about through a depletion of growing stock, change in composition from valuable to less desirable species, reduction of soil fertility, and an increase in insect and disease infestations.

Forestry and the Land Use Problem

The existence of a land use problem in the border area between the fertile Corn Belt and the more rugged portions of the unglaciated sections, has been long recognized. Much of this area lies within the limits of the old Illinoian glaciation where the soils are thinner and much more leached than the more recent soils of the Wisconsin drift area of the Corn Belt proper. Excessive clearing for agriculture has resulted in early depletion of these soils. The seriousness of the problem, however, has been masked by the fact that actual abandonment has progressed at a much slower pace than in other regions. As rapidly as land was offered for sale through tax delinquency, much of it was "grabbed up" by some one with a little money and much optimism, farmed for a few years and again permitted to go delinquent. Active abandonment in this region has also been retarded by a back to the farm movement, temporary in nature, caused by the recent industrial unemployment in the cities. The region is just awakening to the fact that its soils are suffering tremendous losses through erosion and that vast areas are being lost to agriculture. Recent estimates for Illinois alone place the ultimate area of land, which will pass out of agricultural use, at 7,500,000 acres. A total area of 17,000,000 acres for the five Corn Belt states is believed to be conservative.

The theory that these lands could be converted into permanent pasture has been shown in many instances, to be impractical and uneconomical. The necessary investment for fertilizing and liming extensive areas of impoverished land often makes pasture production prohibitive. In fact, soil specialists are of the opinion that much of the present area of perma

nent pasture is deteriorating rapidly through lack of proper maintenance. The contention of foresters, therefore, that timber production through public acquisition and reforestation offers the most promising future for extensive areas of these lands, is now being rather generally accepted.

Watershed protection and streamflow regulation have already been pointed out as land use problems of great magnitude. The problem of checking serious sheet and gully erosion on millions of acres of good agricultural soils must also be solved if they are to be saved from ultimate abandonment. The Bureau of Chemistry and Soils states that extensive areas in the very heart of the Corn Belt are being impoverished through erosion and that fertile top soil in northern Missouri has been known to erode at the rate of 106 tons per acre per year. Erosion control on level and gently rolling slopes is a problem for the agricultural engineers if these areas are to be kept in cultivation. On the more rolling slopes, however, a combination of forestry, engineering, and good cropping is required; and many areas must be removed entirely from cultivation to prevent not only their own destruction, but to safeguard adjacent properties, streams, and water resources. Reforestation of these slopes offers the most logical control measure.

Serious consideration must be given to the very acute need in the Central States for much greater recreational facilities. Provision must be made in all plans for public acquisition to provide suitable camping, fishing, hunting and other out-of-door diversions for a dense and continually growing population which at present must seek its recreation at considerable distance. Some of the states have already started the development of such a program.

Farm Forestry and Its Future

In the heavier timbered sections of the Central States, the future of forestry is dependent on the development of forest practice on the larger public and private holdings. However, 80 per cent of the present timber land area in the entire region is in units smaller than 100 acres, and it is obvious that any adequate forest program must also consider the proper management of these holdings. The farmwoods constitute by far the greatest percentage, representing approximately 56 per cent of the total forest area of the region.

This farmwoods acreage of approximately 30,000,000 acres may be divided into two classes: first, the very small, isolated tracts of from 5 to 20 acres, typical of the woodlands of the Corn Belt; and second, the somewhat larger, often more or less contiguous, tracts common in the unglaciated sections. In this region, the term "farmwoods" is usually accepted as referring to the smaller, isolated tracts. For this reason, the larger tracts of farm woodland found south of the Corn Belt have been included and discussed in the section on the Management of Upland Forests.

There is no question but that the local demand for timber, in the agricultural sections of the Central States, will always be greater than the production which can be expected from the farmwoods within these sections even under intensive management. The opportunities for profitable forest practice in farmwoods are very favorable: a direct subsidy through high freight rates for timber from the South and West, the increasing need for high-grade hardwood lumber, and the favorable forest tax laws in Ohio, Indiana, and Iowa are all factors which should encourage farm forestry.

Regardless of the increasing importance of farm forestry, it is an indisputable fact that the percentage of farmwoods has been steadily decreasing over the entire area. In the Corn Belt the situation has become critical. Excluding the prairie areas, approximately 84,000,000 acres of the Corn Belt were originally heavily timbered. A

study of the 1930 census records for those counties east of the prairies indicates that only 11.1 per cent of the farm land is now classified as wooded. Since over 95 per cent of the rural real estate of these counties is in farms, it is evident that this percentage represents practically the entire forest land in this vast area. This reduction in acreage would not be so serious if the remaining farmwoods represented productive timber land. The most distressing feature, however, is that most of these so-called woodlands are in reality so badly understocked, overmature, and decadent as to be largely worthless from a timber production standpoint.

Over 90 per cent of the farmwoods in this extensive area are grazed to the extent that the woods are slowly being converted to open pastures. In fact, fully 50 per cent of the grazed woodlands have reached the stage where they are no longer capable of yielding forest products. The majority of these stands are approaching extinction. Census records from 1910 to 1925 indicate that the area of woodland on Corn Belt farms has been decreasing at an almost constant rate of nearly 2 per cent per year.[1] Unquestionably this decrease is largely due to the final clearing off of these relict woodlands or their ultimate transition to open pastures. The almost total disappearance of woodland from any section will undoubtedly have serious economic, sociologic, and aesthetic effects on farm and community welfare. The upsetting of certain climatic, edaphic, and biotic balances is also possible. The scarcity of insectivorous birds of value to the farmer is directly traceable to the passing of the farmwoods in certain sections of the Corn Belt.

It is obvious that if the farmwoods are to be saved and brought back to a productive condition, they must receive far greater consideration than in the past. The ownership of much of these lands is scattered among thousands of individuals, often retired farmers or other non-resident holders, most of whom are unaware of the economic importance of their woodlands to themselves or to the welfare of the community, state, or nation. The economic, silvicultural and utilization problems peculiar to the farmwoods of the Corn Belt must be solved if these areas are to take their place as a part of any well-managed farm or to play any important rôle in the forest economy of the Nation.

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[1]A slight increase in total area in 1930 resulted from the back to the farm movement since 1929. Computing the data for 1925 and 1930 on the basis of percentage of total farm land in woods, it is evident that the decline is continuing at approximately the same rate.

WRITING THE NEWS OF FORESTRY

By HENRY E. CLEPPER

Pennsylvania Department of Forests and Waters

The greatest boon that can come to any movement, depending partly or wholly upon public support, is a friendly press. And forestry, practically from its inception in America, has had one. Here are valuable suggestions for the constructive use of publicity.

A REPORTER who calls upon a forester for news should be treated with friendliness and courtesy, and should never be sent away empty handed. Often a newspaper man will discover news interest in activities that to the forester have no news value. Since the business of most newspaper men is writing, it is unnecessary when dealing with a reporter on a large city paper to write material for him. Frequently, however, a forester must write local forestry news for a small town or weekly paper if it is to get published.

Now, there appears to be a generally accepted belief that writing news is a highly esoteric art to be mastered only by certain individuals gifted above other men and only after years of diligent application to its mysteries. Like most generally accepted opinions, this one, too, is only partly correct. There are, it is true, certain tricks to the newspaper man's art—trade secrets, as it were, and short cuts to be learned—but these may be quickly acquired by any intelligent forester not too deeply immersed in the details of his work to study his local newspaper with a view to applying the principles of good copy writing to his job.

The old saw that a good newspaper man must have a nose for news is true if we acknowledge the fact that no one, with the possible exception of idiots and morons, lacks news sense. As long as people gossip—and who doesn't?—about other people and things and ideas, they have adequate noses for news. And the alert forester, if he has the germ of the old crusading and missionary spirit that men like Fernow, Hough, and others of the pioneers possessed, will want to tell the world about what he is doing.

How can he set about doing this and just what is he going to say? A newly graduated forester recently confessed to the present writer that he was very ambitious to learn to write for the newspapers and magazines, but that he had considerable difficulty in finding matters to write about. Sooner or later this problem confronts everyone, even the best known and most highly paid journalists. But foresters generally do not need to hunt for news. They are making it all the time—if they only knew it. But this is a matter that we shall discuss later.

Let us assume, then, that most foresters, whether in governmental or private employ, at one time or another furnish news to the press. This information should be given with a definite purpose in view; namely, to promote forestry. With us news should not be an end in itself. We are not functioning to supply the press with copy and we are not organized to provide the public with entertainment. We endeavor to promote forestry in this country by giving newspapers information about our work, information which they are usually willing to print because it is of interest to their readers.

It cannot be too strongly emphasized that exploiting personalities through publicity is neither good forestry nor good news. When acting in our official capacities as foresters there should be, prac-

tically and ethically, only one consideration when supplying news. And that is: Does this message promote forestry? If it does not, then, no matter how excellent a news story it may be in other respects it is certainly not good forestry news.

Publicity, after all, is simply information designed to promote a special person or thing. It is of interest to a limited number of readers only, and is furnished gratis to newspapers for free printing. One reason that it is important to keep forestry news free from personal publicity is because newspaper men are quick to detect a puff, which has practically no news value and is of limited general interest.

The worth of forestry news, like all news generally, may be measured by one universal yardstick—its interest value. That is the fundamental of a first-class news story. And it should not be forgotten that the best news is that which interests the greatest number of people.

Let us look at forestry news, analyzing, briefly, the various types of stories as we go.

Stories that contain the elements of survival and self-preservation fill most of the columns of the average newspaper. Usually events of this type are unexpected and infrequent in the sense that they are happenings not in the ordinary course or routine of life. Perhaps the outstanding occasions affording news in this class are crimes, fires, accidents, and deaths. Because they are extraordinary and sometimes shocking people want to know about them.

Although crimes rarely occur in the ordinary work of the forester, accidents, fires, and other unexpected occurrences are more common. A forest fire, especially if it is of a spectacular nature, is always news, though how important from the news angle depending upon its extent, property losses, and the time and number of men required to extinguish it.

There are two ways, one of them right and one of them wrong, by which we, as foresters, can present news stories of fires. The wrong way is to furnish all their spectacular details and let it go at that. The other, the right way, is to write up all the details, spectacular or otherwise, but embody in the story a suggestion concerning the wastefulness and undesirability of forest fires.

To have our efforts reinforced by public opinion we must create a favorable public sentiment by judicious use of news material.

Occasionally we hear of freak forest fires, but ordinarily discoveries of freaks in nature, such as unusual trees or five-legged animals, provide the news of the extraordinary type.

Inventions, particularly of new ways to detect fires, plant trees, or cure poison ivy, make interesting news. Price fluctuations of forest products and weather fluctuations as they affect forest conditions should not be neglected.

Violations and prosecutions probably come as close to crime news as we find in forestry work. Frequently, publicity given to prosecution for infractions of forest laws has an excellent effect in stopping violations. There is almost no limit to the possibilities for extracting good news material from our law enforcement activities.

It must be remembered that many events common enough in the forester's routine appear very remarkable to the general public, hence no opportunity should be missed to tell the unusual or uncommon story and tie it up in some way with forestry.

Stories of competition and accomplishment have a tremendous appeal to all classes of people. Witness the weekly and monthly flood of success stories in the magazines and Sunday supplements. The successful ending of a particularly serious fire season is news, and when the dramatic feature of the fight to control the fires is emphasized the public enjoys

reading about it because of the element of struggle involved.

Stripping all weighty psychology from the reason for the avid hunger of the public for this type of news, we find that it devolves simply from man's primitive love of a fight. A battle, a struggle, a contest of any kind, whether a war in China, an auction bridge contest in New York, or a combat between pathologists and the deadly white pine blister rust, has news value.

Foresters, without always being aware of it, participate in countless situations all of which lend themselves to special news slants. Simply to report that a fire burned one hundred acres on Sharp Mountain on July 4 and was extinguished by Warden Jones' crew requires only a few lines. But several paragraphs may be written if the dramatic aspects of fighting the fire are played up. Then after presenting the facts about the fire and the fire situation generally in the district, a statement may be appended to the effect that Forester John Smith made a plea today that all motorists, campers, and transients in the woods during the prolonged dry season use extreme care with matches, tobacco, and camp fires. A news story about a fire provides a ready hook upon which to hang a brief forestry message, such as one urging care with fire in the woods.

When the activities of the forest are concerned with business and financial operations they are almost always overlooked as possible sources of news, though nine times out of ten they are worth press notice. Improvements in the forest, demonstrations of forestry practice, efficiency in forest management—all these possess news value. Promotions and appointments, too, are always of interest, locally at least.

Then, there are the wide open spaces! How often have we read about them and seen them in the movies *ad nauseam*? And yet the out-of-doors has a sentimental appeal, which if handled without affectation and gush, strikes a responsive chord in the minds of most people. Much of the public support given to our efforts to control forest fire derives not so much from a consideration of the economic value of the timber as from a sentimental attitude that the beautiful trees must not be destroyed. Similarily, stories of historic and old trees that have some association with individuals, such as the Penn Treaty Elm, have tremendous romantic appeal.

Likewise, if deftly handled, a story that links up a romantic legend concerning children, friendship, love, or even tragedy with trees and forests is almost sure fire. This feature of news presentation is commonly called the "heart throb" angle. Unlike straight news, features are written with a slant in which the emphasis is so placed as to create an emotional impression on the reader.

This twist in the writing does not mean that the stories are fakes. Far from it. A feature is a quite legitimate form of news treatment, and though the writer need not be bound by strict facts in the case of obvious humor, the idea is to improve the actual news matter by light, frivolous, serious, fanciful, sentimental, humorous, personal, or strictly impersonal writing.

Few people can resist an appeal to their emotions. Hence any story that excites their sympathy, humor, love, indignation, or anger is from a news standpoint successful. The human interest story, which emphasizes the personal element in the world's affairs, is read avidly by the public. Why? Because among the principal topics of interest to mankind—including persons, things, and ideas—persons undoubtedly receive the greatest attention.

To illustrate. A story of how Mary Jane, age six, the daughter of Forest Ranger Tom Brown, met a black bear while carrying her father's lunch to him in the Penn State Forest and how the

bear stole the lunch without harming the child, would make a news story that would be copied far and wide. Whereas, a story concerning the acquisition of a new state forest might receive but limited publicity. Now, there is no comparison between the two. One is concerned with the promotion of the forestry movement by a substantial increase in the state forest acreage; the other is simply a human interest story. The one deals with economics, which is apt to be dull. The other excites one's powers of sympathy, fear, and romance by its appeal to the instinctive affection that all people have for children and animals.

Of course, news stories such as the foregoing do not occur every day in the work of the average forester, but occasionally something just as startling may break and when it does no time should be lost in giving it publicity. The point is that many people tend to consider the lives and work of foresters from a romantic viewpoint, and, such being the case, it is perfectly legitimate to satisfy their conception.

The source list of stories is almost inexhaustible. Consider all the local traditions and folklore concerning trees and forests that are of interest, the woodland areas having historical backgrounds. Folks enjoy reading about animals and birds, particularly snakes. A good snake yarn will often travel halfway across the continent.

Adventures that happen to foresters and their families and to forest workers, such as getting lost in the woods, make useful copy. Sports activities and hunting, fishing, camping, and hiking expeditions are typical of the kind of material that goes to make up the nation's press.

Genuine humor, a mighty rare commodity in the news of the world, is authentic newspaper fodder. If we can impart to the public some particular bit of forestry knowledge by making people laugh we must not neglect the opportunity.

Although the majority of newspapers devote most of their space to the various kinds of news previously enumerated, they do not entirely overlook the arts and sciences. There is news value in the so-called dull technical subjects, and in economics and aesthetics. Usually news of this sort is written in the style of features by writers trained in, or with knowledge of the topic. Newspapers will often open their columns to material of a technical nature, especially if it has been written in popular style.

Occasionally we make use of articles of this kind to reach special interests, such as sportsmen, farmers, lumbermen, and educators. Modern newspapers, in fact, cannot afford to ignore specialized news. Practically every city newspaper now reports information about the financial and business worlds. They provide a woman's page for the housewife, sports news for the sportsman, bed-time stories for the kiddies, and a host of other special subjects, including literary reviews, radio digests, sermons, and (God help us!) a new poem a day.

It follows that news directed to special interests presupposes an audience with more than rudimentary knowledge of the subject. While it is a good idea not to go over the heads of general readers, yet when addressing special readers it is often possible to be more technical. An article, for example, on seeding and planting trees which is entirely intelligible to a farmer might, on the contrary, be too technical for a city man without agricultural experience. Usually a good rule to follow, therefore, is to write even technical information in as elementary a form as possible.

Another way to use articles of the informative type directed to specialized groups is by appealing to their hobbies. Stories concerning the destruction of forests by fire might or might not make an appeal to hunters, though they are almost certain to be interested if the point that

fires destroy game is stressed. In like manner an article on the relation between forests and stream flow might be pretty dull reading, but if it is linked up with the conservation of fish life the fisherman is apt to be interested.

In short, newspapers are usually willing to print stories of the technical or informative type because of their appeal to specialized interests, but the larger the interested group is, the more acceptable will the story be to the publisher.

Many books and other publications on the art of writing for the press are available to the forester who cares to delve into this very interesting subject. There are several that the present writer has found extremely useful, and these he commends to the attention of any one wishing a further knowledge of what publicity men—or public relations experts, to use their more euphonious designation—call the writing game.

The exceedingly comprehensive bibliography of news writing need not concern us, though it should be understood that the ten books listed here do not by any means exhaust the subject. Not all of them, perhaps, will be of general interest; several are listed because they contain one or more particularly good chapters, and are so described.

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DIAMETER GROWTH OF PONDEROSA PINE AS RELATED TO AGE AND CROWN DEVELOPMENT

By HERMANN KRAUCH

Associate Silviculturist, S. W. Forest and Range Experiment Station

This paper deals with a subject of much importance in forest management. It evolves in forestry the principle that growth is directly related to the active leaf area. This principle is universally accepted by plant physiologists, but where foresters have accepted it they have done so rather unconsciously in empirical deductions.

It has been assumed in marking practice in the Southwest that the diameter growth of trees is directly related to age and crown development. In order to determine to what extent this is true an analysis has been made of the growth data supplied by a number of permanent sample plots in cut-over stands of ponderosa pine on the Coconino and Tusayan National Forests. The trees have been measured at five-year intervals over a period of 20 years. In preparing the data for analysis the trees were grouped according to the following classification:

THRIFTY, NORMAL TREES OF DIFFERENT CROWN SIZE

Class 1. Very large crowns, mostly isolated or widely spaced trees.

Class 2. Crowns somewhat smaller than in Class 1. Largely dominants.

Class 3. Medium size crowns. Mostly dominants and codominants in groups of medium density.

Class 4. Small crowns. Largely trees in the intermediate crown class; in densely stocked groups.

MALFORMED AND UNTHRIFTY TREES

(No differentiation as to crown size)

Class 5. Thrifty crowns but dead or badly forked tops.

Class 6. Thrifty crowns but injured boles.

Class 7. Unthrifty trees, as indicated by thin crowns or pale foliage.

Class 8. Distinctly unthrifty trees, as indicated by very thin crowns, dead branches and disease.

The present analysis deals only with the first four classes which are based on differences in size of crown as determined by ocular estimate. It should be noted that only thrifty normal trees are included in these classes. The terms "black jack" and "yellow pine" are here used to distinguish two broad age classes; the former representing immature trees under about 150 years old and the latter mature and overmature trees.[1]

Although the factor of release has a great bearing on the rate of growth no attempt was made to segregate the trees on this basis. There are, in fact, very few thrifty trees on these plots which can be said to have been fully released. This is because the earlier marking policies did not call for thinning of the black jack groups and, as will be noted, the majority of the trees dealt with here belong to this age class. Root area is probably as important as crown area, and is to a large extent reflected in crown area. Other factors such as crown density, character of soil and depth of litter have not been segregated, it being assumed that their

[1] The transition from black jack to yellow pine takes place when the trees have reached an age of about 150 years. The bark then gradually changes from black to dark brown or cinnamon color and finally in very old trees it becomes yellowish-brown. Age is also roughly indicated by diameters but this relation holds only in dealing with averages.

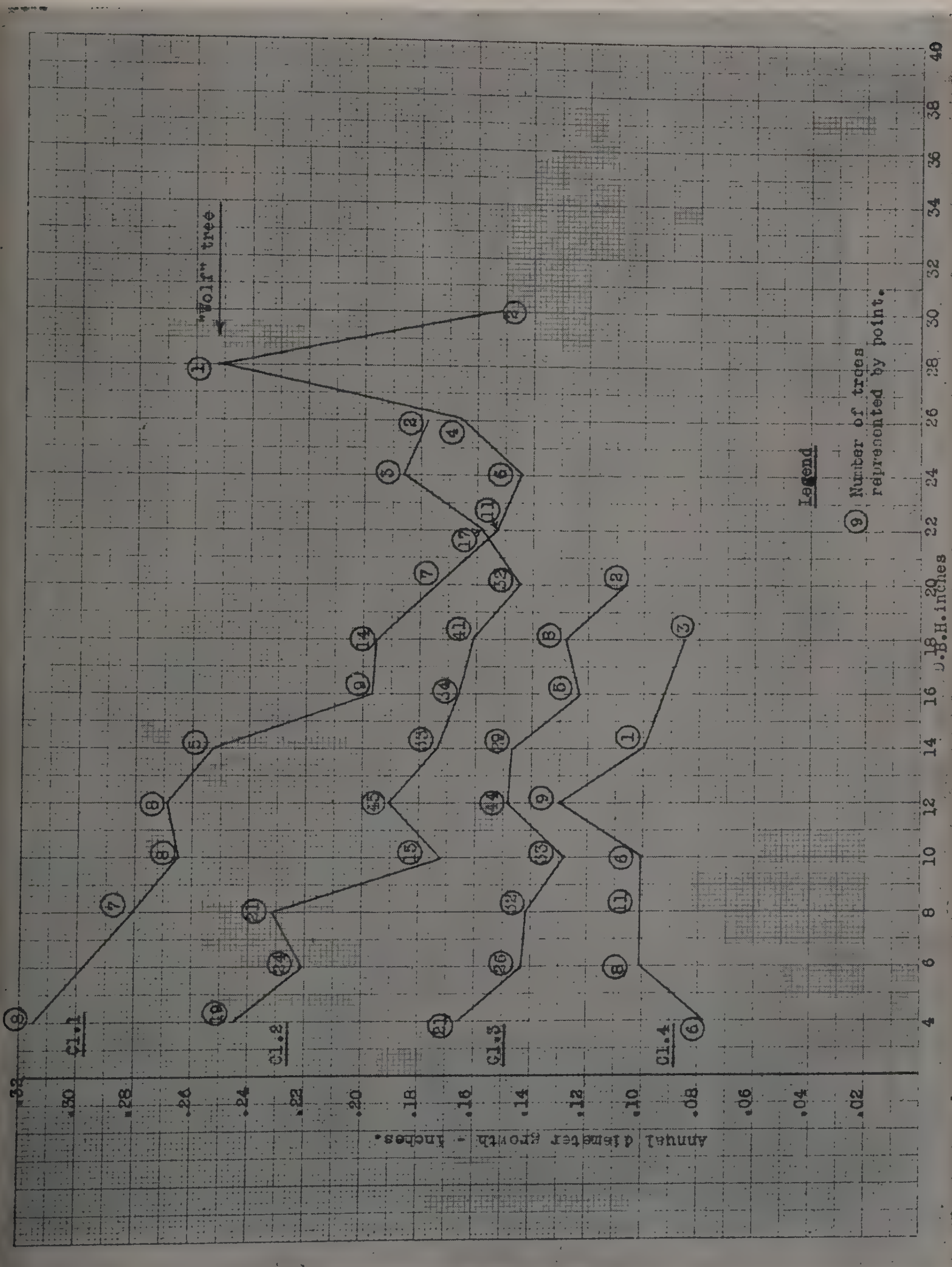


Fig. 1.—Relation of crown development to the diameter growth of thrifty, normal black jacks.

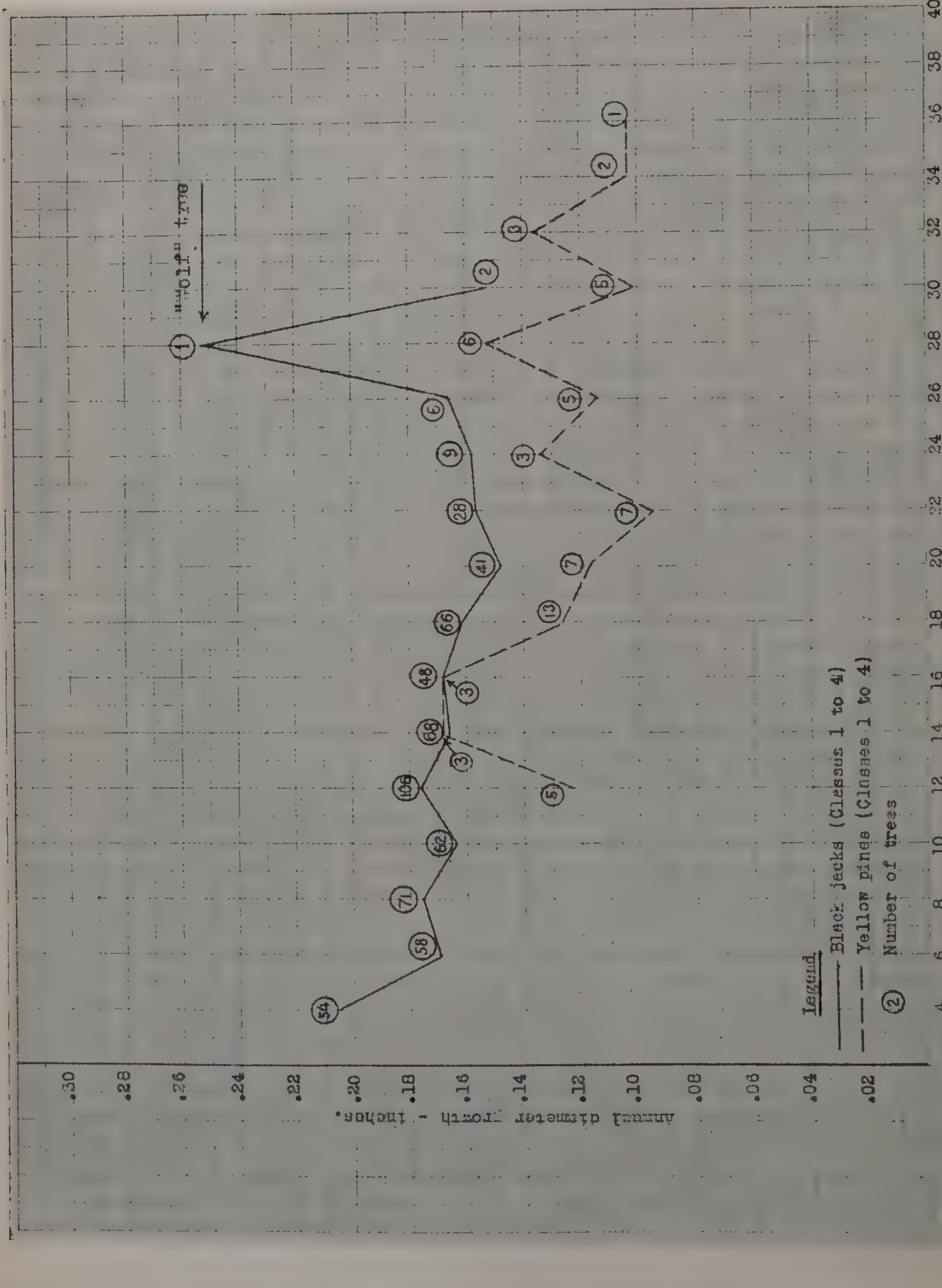


Fig. 2.—Diameter growth of thrifty normal black jacks and thrifty normal yellow pines (Cl. 1-4 combined).

effect would be more or less uniformly distributed among the several crown classes.

Results

Table 1 and Figure 1 point plainly to a higher rate of diameter growth in the classes representing the best crown development. The relationship is especially outstanding in black jack. It is to be regarded as a direct expression of crown area supplemented by root area which, though not taken into account in the classification, is observed to vary in a general way with crown area.

Yellow pine shows a slower growth rate than black jack of the same diameter. Whether this difference is due to age *per se* or is merely a further reflection of leaf area is not definitely known. Yellow pine is generally regarded as less vigorous than black jack, using height growth and density of crown as criteria. The slower diameter growth of yellow pine, however, is not to be regarded as a direct measure of declining volume growth, because yellow pine is consistently taller than black jack of the same diameter, and thus must distribute its increment over a bole that is greater in length.

Figure 1 and Table 1 also show that the rate of growth tends to fall off as the trees become larger in diameter. But, although the decline is especially marked in Classes 1 and 2, it is much less so in Class 3, in fact, Class 4 indicates a somewhat reverse relationship. The reason for this is that where no distinction is made in crown classes the influence of the relatively large numbers of trees of small and intermediate sized crowns in the lower diameter classes is such as to pull down the average growth in these diameter classes, while in the larger diameters small crowned trees are too few in number to have any appreciable effect. This is demonstrated by the graphs in Figure 2 showing the average growth of trees in Classes 1 to 4 combined.

Table 1

DIAMETER GROWTH OF BLACK JACK AND YELLOW PINE BY CROWN CLASSES

Diameter and age classes	Mean annual growth				Number of trees measured			
	Cl. 1	Cl. 2	Cl. 3	Cl. 4	Cl. 1	Cl. 2	Cl. 3	Cl. 4
	In.	In.	In.	In.	No.	No.	No.	No.
4″-11″								
Black jack	.287	.220	.143	.100	23	79	112	31
Yellow pine	— No data —							
12″-20″								
Black jack	.219	.170	.144	.124	39	169	88	13
Yellow pine	.152	.144	.139	.073	2	6	15	3
21″-30″								
Black jack	.161	.159	.152		28	38		
Yellow pine	.143	.111	.125		5	12	11	
31″-40″								
Black jack	— No data —							
Yellow pine	.128	.193			6	5		

DOES IT PAY TO RESERVE THRIFTY MATURE TREES OF PONDEROSA PINE FOR FUTURE CUTTING?

By HERMANN KRAUCH

Associate Silviculturist, S. W. Forest and Range Experiment Station

In this article a departure has been made from the usual idea prevailing in the Southwest and quite generally throughout the Forest Service that large trees which are more than an average risk should be cut. This idea would probably be sound if it were not for the fact that under present conditions we have extensive areas of virgin timber which can not be cut within 50 years. Under these circumstances there will probably be less loss by leaving thrifty large trees on cut-over areas than if these trees are cut and a corresponding volume of decadent trees left uncut in virgin stands.

STUDIES of the growth of thrifty mature trees in cut-over stands of ponderosa pine in the Southwest have shown that such trees, when well released, will resume growth at a greatly accelerated rate and continue at this rate for many years.[1] This suggests that in logging virgin stands most of the thrifty mature trees might well be reserved for future cutting. An additional silvicultural justification is found in the fact that large trees are the best seed producers.[2] Economic justification, however, involves other considerations such as mortality and capital investment.

Where forest stands are made up of many different age-classes it is difficult to determine the area occupied by each class. It is for this reason that in dealing with the increment of ponderosa pine in the Southwest, little attempt has as yet been made to determine the increment of the different age-classes on an area basis. Furthermore, even-aged stands sufficiently extensive to provide adequate sample plots are seldom to be found. An area approaching the desired condition—one which had been selectively logged and on which most of the trees were mature but thrifty—was located in the fall of 1926 and a sample plot of eight acres established. The present article is based on a five-year record of this plot. Although the application of the data is limited by the short period involved, the results are significant; moreover, the data are thought to be fairly reliable because 20-year records on large plots show no great variation in growth between five-year periods.

The plot is typical of the best timber stands in the Coconino National Forest. The original volume was 21,390 board feet per acre, of which 14,353 board feet, or 67.1 per cent, was cut and 7,037 board feet retained. The excellent quality of the site is indicated by the heights of the reserved trees, which average 100 feet for individuals between 21 and 32 inches, d. b. h.

Before cutting, this plot had an average per acre of 37½ trees between four and thirty-four inches in diameter. There were 33 trees per acre above 12 inches in diameter, and 18 above 20 inches. The extent to which the retained trees were released through a partial cutting of the stand is indicated by the fact that two-thirds of the total number were removed, including all above 34 inches. Five per cent of the total number of trees retained were classed as unthrifty, but of those above 30 inches in diameter 20 per cent were classed as unthrifty. A view of the stand as it appeared after cutting is presented in Figure 1. Table 1 shows the distribu-

[1] Krauch, H., 1924, Acceleration of Growth of Western Yellow Pine After Cutting, Jour. Forestry 6:39-42.

[2] Pearson, G. A., Natural Reproduction of Western Yellow Pine in the Southwest, U. S. Dept. of Agric. Bul. 1105.

tion of trees and volume by broad diameter classes immediately after cutting. Advance reproduction was practically absent.

The growth in different diameter groups over a period of five years is shown in Table 2. Diameter growth increases with the size of the trees through the 21 to 25 inch class, and then declines. This relation is essentially in accord with that found on other cut-over plots in this region. A falling off in the growth rate of the trees above about 25 inches, d. b. h., is to be expected since most of these trees are mature and presumably are less vigorous than younger trees. According to this reasoning the most rapid growth should be in the lower diameter classes, and this would probably be true but for the fact that these classes occur mainly in dense groups from which relatively few trees are removed in the usual cutting practice. A careful analysis of the average cut-over stand with respect to density and crown development of reserved trees would reveal a relation about as follows: in the lower diameters, up to about 20 inches, close spacing and a relatively large number of poor crowns; in the intermediate diameter classes more open spacing and uniformly good crown development; in the higher diameter classes, wide spacing and good crown development but declining vigor on account of advanced age.

The volume growth per tree is highest in the 21 to 25 inch class. The decline above 25 inches, d. b. h., indicates that the larger trees are relatively inefficient wood producers, although the decrease in volume increment is in a measure offset by higher quality increment.

Increment per acre is given as gross rather than net because all of the mortality happens to consist of a single 29 inch tree, which would place the 26 to 30 inch class at an unfair disadvantage in comparison with other classes. The death

Fig. 1.—Sample plot in a cut-over stand of ponderosa pine on the Coconino National Forest, Trees over 25 inches, d. b. h., make up 66 per cent of the volume.

(by windthrow[3]) of this one tree accounts for an average annual loss of 5.8 cubic feet or 36 board feet per acre which exceeds the increment in the 26 to 30 inch class and reduces the per acre increment of the stand from a gross value of 119 board feet to a net value of 83 board feet. Records on extensive plots over a period of 20 years indicate that the loss on this plot is somewhat above what might be expected for this type of stand, and that over a longer period it would be distributed over the entire range of diameters, the highest per cent, however, falling in the upper classes.

Analysis of the gross increment with reference to the part played by the several diameter classes reveals relationships worthy of note. The lower diameter classes are high in increment per cent but low in actual volume increment, whereas in the higher diameter classes the relation is reversed. If all the trees above 20 inches, d. b. h., had been cut, the per cent of increment in board measure would be 4.25 but, because of the small growing stock (729 board feet, the annual increment per acre would be only 31 board feet. The 21 to 25 inch trees increased in volume at a rate of only 2.51 per cent, but they added 42 board feet to the acre increment. By leaving these, in addition to the smaller trees, the growing stock is increased to 2,405 board feet and the annual increment per acre to 73 board feet. Such a growing stock is quite comparable in volume to the residual stands in present day Forest Service cuttings in Region 3, although in practice these cuttings would not conform strictly to any diameter limit. The 26 to 30 inch trees show a further decline in increment per cent, but they contribute a gross increment of 31 board feet per acre. The 31 to 34 inch class, containing 2,127 board feet, contributes only 15 board feet per acre, yielding a gross increment per cent of 0.71. According to 20-year records on other areas mortality will exceed increment in this class. The same records indicate that mortality in the 26 to 30 inch class, as well as in the lower diameters, will be low enough to permit a substantial net increment.

Whether major emphasis should be placed on increment per cent or increment per acre depends on ownership and the objects of management. In the national forests the rate of interest on the investment is less important than sustained yield. In stands containing a preponderance of mature age-classes, there is danger of overcutting now at the expense of the future. Where, as in the illustration cited in the preceding paragraph, the growing stock is reduced to 729 board feet per acre, a growth of 4.25 per cent is less appealing when it is considered

TABLE 1

STAND PER ACRE (AFTER CUTTING), AND DISTRIBUTION BY DIAMETER CLASSES IN 1926

Diameter classes	Average diameter	Stand per acre			Distribution per cent		
		Trees	Volume	Volume	Trees	Cubic feet	Board feet
Inches	Inches	No.	Cu. ft.	Bd. ft.	Per cent	Per cent	Per cent
4 - 11	8.7	1.7	10.5		13.6	.8	
12 - 20	16.1	4.9	175.4	729	39.2	13.9	10.4
21 - 25	24.5	2.5	299.9	1,676	20.0	23.7	23.8
26 - 30	28.1	2.1	426.6	2,505	16.8	33.8	35.6
31 - 34	32.8	1.3	351.8	2,127	10.4	27.8	30.2
4 - 34	21.6	12.5	1,264.2	7,037	100.0	100.0	100.0

[3] The agents most commonly responsible for the death of large trees in this region are wind, lightning, and bark beetles. Among trees below about 20 inches, d. b. h., mortality is due mainly to mistletoe, suppression, and bark beetles. The author has discussed this subject in a previous article, "Mortality in Cut-over Stands of Western Yellow Pine in the Southwest." JOUR. FOR., December, 1930.

that 161 years will be required to produce a second cut of 5,000 board feet.

Under present conditions in the national forests, where large bodies of virgin timber will remain uncut for 50 years or more, increment per acre rather than increment per cent should be the chief object in managing cut-over lands. Cutting lightly and thus leaving relatively large residual volumes will increase the net increment per acre. Mortality will be greater in actual volume than it would be after heavy cutting; but, considering the forest as a whole, this will be more than offset by decreased mortality in virgin stands which would be covered more rapidly under a program of light cutting. Obviously, the leaving of large residual volumes has practical limitations. Some mature stands are so decadent that it is difficult to find as much as 3,000 board feet in trees suitable to leave. On this plot it certainly would have been advantageous to remove the trees classed as unthrifty, most of which are in the 31 to 34 inch class; and, because of their slow growth and high susceptibility to loss, probably all trees in this class, except those required for seed, should have been removed. Presence of advance reproduction would also exert an influence toward heavier cutting, although in stands as heavy as this, advance reproduction usually occupies but a small portion of the area. Another limit to the volume that can be left is the cut required to make a logging operation feasible.

It was formerly and, to a less extent, is still considered good practice in the Southwest to mark every tree that might be considered a bad risk, unless distinctly needed for seed. Trees above 24 inches, d. b. h., and over five logs in height were regarded as especially bad risks. It is true that trees of this size are more susceptible to being struck by lightning or windthrown than are smaller ones; nevertheless, many of them escape and those which persist put on increment that is not only large in volume but also high in quality. Considered individually, large trees left for growth do involve a great risk; but when it is considered that leaving a thrifty large tree here makes it possible to salvage a declining large tree somewhere else the risk is justified. Although young growing stock is preferable to old, this is of less importance than that it be adequate to yield substantial increment that will supply successive cuts at relatively short intervals.

TABLE 2

ANNUAL GROWTH IN DIAMETER AND VOLUME BY DIAMETER CLASSES, 1926 TO 1931

Diameter classes	Growth per tree			Gross increment per acre		Gross increment per cent		No. of trees
	Diameter	Volume	Volume	Volume	Volume	Cu. ft.	Bd. ft.	on plot
Inches	Inches	Cu. ft.	Bd. ft.	Cu ft.	Bd. ft.	Per cent		
4 - 11	.179	.29		.5		4.76		14
12 - 20	.186	.97	6.3	4.7	31	2.68	4.25	39
21 - 25	.217	2.50	16.6	6.3	42	2.10	2.51	20
26 - 30	.147	2.28	14.6	4.8	31	1.13	1.24	17
31 - 34	.114	1.96	12.2	2.5	15	.71	.71	10
4 - 34	.186	1.67	10.9	18.8	119	1.49	1.69	100

WEATHER AND FOREST FIRE HAZARD WITH SPECIAL REFERENCE TO THE UPPER ALTITUDINAL SPRUCE-BALSAM FIR REGION OF NORTHERN NEW YORK

By PAUL W. STICKEL[1]

Associate Silviculturist, Northeastern Forest Experiment Station[2]
In coöperation with
The Conservation Department, State of New York and Finch, Pruyn and Company, Inc.

With the alinement chart[3] presented herein, local forest officers can estimate from data obtained from a sling psychrometer current duff moisture content and degree of inflammability. When used in connection with daily weather forecasts, such fuel moisture-inflammability estimates enable one to predict the degree of future forest fire hazard. Besides showing that a definite relationship exists between weather and forest fire hazard, the present investigation has disclosed that in the upper altitudinal spruce-balsam fir region in the Northeast almost complete protection against the drying out of the inflammable materials on the forest floor is given by the evergreen crowns themselves.

DURING the period 1926 to 1930 inclusive, the Northeastern Forest Experiment Station, in coöperation with the agencies listed above, conducted a study of forest fire-weather at Elk Lake, New York, in the upper altitudinal spruce-balsam fir region [*Picea rubra* Link and *Abies balsamea* (Linnaeus) Miller]. The elevation of the area in which this investigation was made is 2,100 feet above sea level. The forests around Elk Lake are typical pure, evenaged, coniferous polewood stands which have arisen on clear-cut areas protected from fire. Red spruce and balsam fir are the dominant species; northern white cedar (*Thuja occidentalis* Linnaeus) and eastern hemlock [*Tsuga canadensis* (Linnaeus) Carrière] are also important components of these forests, and to a much lesser extent, at least as far as frequency is concerned, such hardwood species as yellow birch (*Betula lutea* Michaux) and red and sugar maples (*Acer rubrum* Linnaeus and *A. saccharum* Marshall).

At Elk Lake the relationship between weather and forest fire hazard was determined by duplicate meteorological stations placed in the open and within the green timber. The stations were maintained from around April 15 to November 1 inclusive. The data, therefore, are representative of that period of the year when fires can and do occur. The open station was situated in a trail having a width of between 30-40 feet and running due east and west. This clearing, though insufficient to permit the inflammable materials on the forest floor to experience the full effect of wind, was large enough, it is believed, to admit fully the influence of solar radiation, air and duff temperatures, relative humidity, etc. The forest station was located within an adjacent

[1]The writer wishes to acknowledge with thanks the faithful services of the following men who were observers at the Elk Lake fire-weather station during the years indicated: J. B. Weber, 1926; B. Weed, 1927; A. W. Spillers, 1928; G. W. Genth, 1929; and J. E. Hetzel, 1930. Miss Mary C. Weldon, junior statistical clerk, Northeastern Forest Experiment Station, rendered valuable assistance in analyzing the data.

[2]Maintained by the U. S. Department of Agriculture at New Haven, Connecticut, in coöperation with Yale University.

[3]Three charts accompanied this article, one is reproduced here. Alinement charts for 11 a. m. and 2 p. m. observations are obtainable upon request from the Northeastern Forest Experiment Station, 335 Prospect St., New Haven, Conn.

stand of green timber whose characteristics are described above.

Simultaneous observations of the following meteorological factors were made at both stations four times daily (8 and 11 a. m. and 2 and 5 p. m.); temperature of the air, surface duff, and top soil, relative humidity, atmospheric and vapor pressures, depression of dew-point, evaporation, precipitation, wind direction, and wind velocity. Concurrently with the meteorological observations, measurements of the moisture content of the inflammable duff layer (twigs, needles, leaves, etc.) at the surface and one inch below the surface were obtained from duff hygrometers in the open and within the forest.

In order to express the duff moisture data by specific degrees of inflammability and hazard, it is necessary to determine, by actual tests with various fire brands, the ease of ignition of duff under different moisture conditions. Such inflammability tests made elsewhere with spruce-balsam fir duff[4] showed that within rather broad limits it is possible to differentiate six zones of inflammability and hazard, depending upon the type of fire brand and surface duff moisture content. The zones of inflammability shown in Table 1 have been used in the alinement chart which accompanies this report.

In analyzing the data[5] it was soon realized that certain meteorological elements were better indices to duff moisture content and inflammability than others. The various elements in their approximate order of importance with respect to duff moisture are: evaporation rate, depression of dew-point, relative humidity, surface duff temperature, air temperature, and number of hours since last measurable precipitation. In no case, however, was the correlation of the individual weather elements and duff moisture sufficiently high to warrant the use of a single factor as an index to fire hazard. By combining several of the more important elements it was possible to obtain a much more accurate index to fuel moisture content and inflammability.

For the Elk Lake area it was found that the most practical measure to use is a combination of relative humidity, air

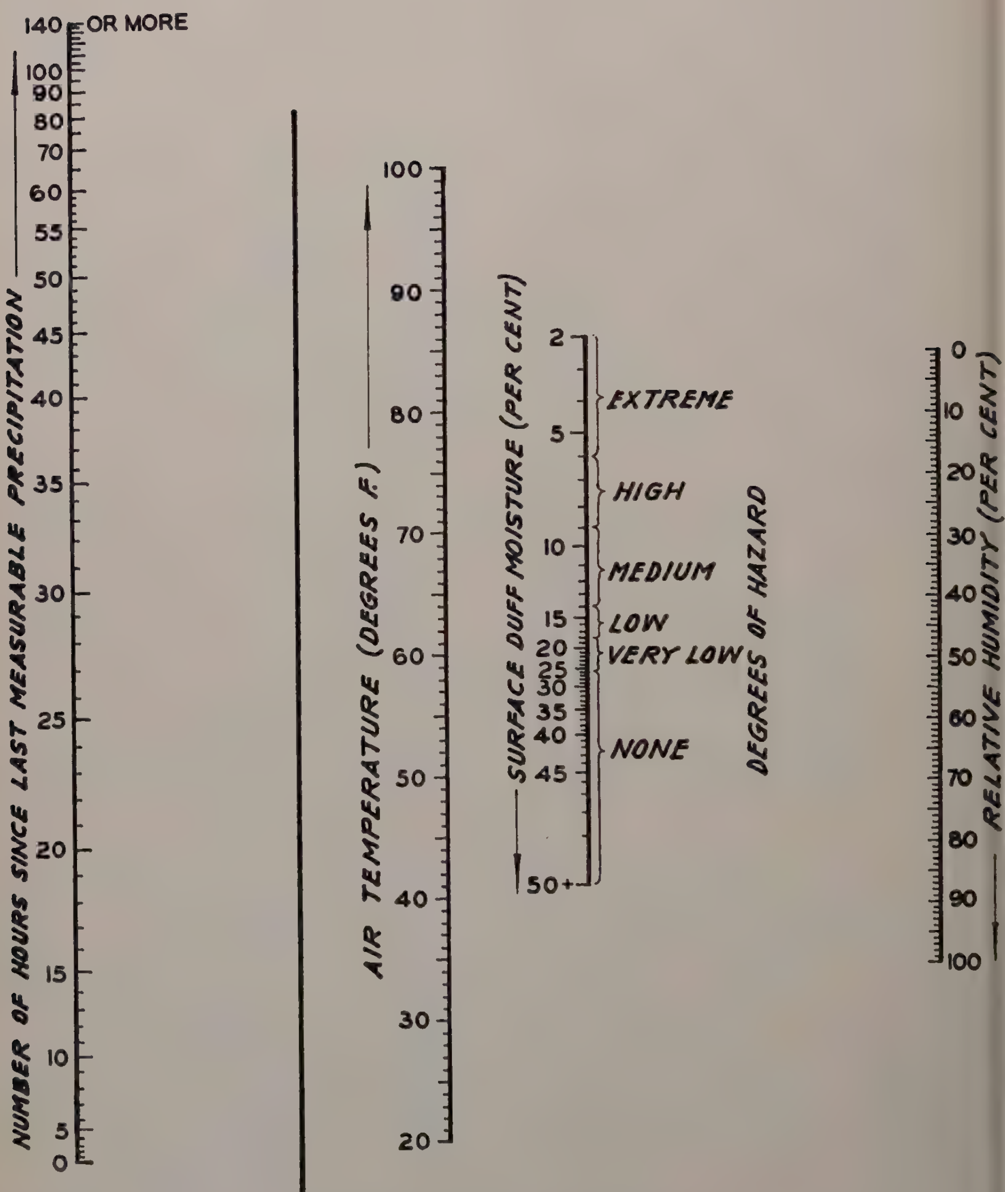
TABLE 1

ZONES OF INFLAMMABILITY IN RELATION TO SURFACE DUFF MOISTURE CONTENT AND THE COMMON CAUSES OF FOREST FIRES

Degree of hazard	Surface duff moisture content	Effective fire brands
	Per cent	
Extreme	Below 6	Locomotive sparks, cigarette butts, pipe heels, matches, and camp fires.
High	6 to 8	Cigarette butts, pipe heels, matches, and camp fires.
Moderate	9 to 13	Pipe heels, matches, and camp fires.
Low	14 to 17	Matches and camp fires.
Very low	18 to 26	Camp fires—duff at edges smolders but fire does not spread.
None	27 or more	None; generally safe from all.

[4]Stickel, Paul W. Weather and Forest Fire Hazard with Special Reference to the Spruce-fir Region of Northern Maine. 19th Biennial Report, Forest Commissioner of Maine, pp. 118-139 incl., illus. 1933.

[5]For a comprehensive description of the methods used in this study as a whole, particularly the statistical technique employed, see Stickel, Paul W.—The measurement and interpretation of forest fire-weather in the western Adirondacks. N. Y. State College of Forestry, Tech. Pub. No. 34, 115 p., illus. Dec., 1931.



See opposite page for explanation.

Fig. 1.—Elk Lake, New York. Alinement chart for 5 P. M. observations.

temperature, and number of hours since last measurable precipitation. In such a combination the influence of all the more important constituents of forest fire-weather—heat, atmospheric moisture deficit, and precipitation—are taken into account. Alinement charts offer a satisfactory method of presenting the relationship between these three weather elements and fuel moisture content and degree of inflammability. Alinement chart for determining surface duff moisture content and hazard in the open at 5 p. m. is herewith presented. No chart has been prepared for 8 a. m. observations because of the comparative instability of weather conditions and fuel moisture content so early in the day.

Besides giving a definite measure of the relation between weather factors and forest fire hazard, the Elk Lake investigation has also shown that the intensity of forest inflammability depends as much upon the degree of exposure of the fuels to weather as upon the type of weather itself. Thus, the fire danger within the forest was very much less than in the open. Because of frequent fogs, relatively cool temperatures, and above all, *the almost complete protection which the inflammable materials on the forest floor receive from the evergreen crowns*, surface duff moisture content at the forest station fell below 50 per cent less than 50 times during the entire five years. The lowest surface duff moisture reading obtained within the green timber was 14 per cent; at no time did the lower duff layer have a moisture content of less than 50 per cent. It appears, therefore, that there is practically no danger from fires starting in this upper altitudinal zone if the forest cover is kept intact. The danger seems confined almost entirely to openings and recently cut-over areas.

The use of the alinement charts will enable the forest warden or ranger to do two things: (a) to classify forest fire danger into specific degrees of hazard, and (b) to determine for himself the existing degree of hazard from day to day. These data when used in conjunction with the regular daily forecasts of the Weather Bureau, will enable him to forecast locally probable future forest fire danger. The substitution of instrumental measurements for rule-of-thumb and experience methods should make for greater consistency in rating hazard and more efficient forest fire control.

The chart (on opposite page) should only be used for determining the surface moisture content of spruce-balsam fir duff in the open at high altitudes. For this purpose weather measurements should be made in the open. Such surface duff moisture estimates apply to condition found in clear cut areas and along roads and trails. Within the high altitudinal spruce-fir forests, particularly within young, dense, pure stands, the continuous evergreen canopy of the trees so protects the combustible materials on the forest floor that inflammable conditions are seldom reached. Where a high percentage of hardwoods occurs in mixture with spruce and balsam fir, the hazard within such stands in the spring and fall will not differ greatly from estimates which apply to open conditions.

To use the alinement chart one end of a straight edge is placed on the proper value of the precipitation-hour scale. The other end is moved until it strikes the proper value on the temperature scale. Holding the straight edge on the point where it strikes the unmarked vertical line, the other end is moved until the correct value on the relative humidity scale is reached. Duff moisture content and degree of hazard in the open are then read at the point where the straight edge intersects the duff moisture scale.—Compiled by Paul W. Stickel, Associate Silviculturist, Northeastern Forest Experiment Station, New Haven, Connecticut, in coöperation with the Conservation Department, State of New York, and Finch, Pruyn & Company.

YIELD OF THE OAK-CHESTNUT-HARD PINE FOREST TYPE IN PENNSYLVANIA[1]

By J. E. AUGHANBAUGH

Pennsylvania Forest Research Institute

Chestnut was formerly the key species in this important forest type. Its loss created many problems of far-reaching significance in the field of silviculture and forest management. One of the important facts to ascertain is the new rate of growth being made by our forests after the chestnut was eliminated. Presence of this tree on the poorer sites was formerly the great redeeming feature which tended to offset the low potentiality of such areas for wood production. It is doubtful if the species which replace it can maintain nearly so fast a rate of growth, even after the forests have been restored to full productivity. Under certain conditions the situation may even warrant attempts at conversion to faster growing conifers (13). Whatever the final solution may be, it hinges on a more definite knowledge of what growth is being made by the replacement species. The death of the chestnut rendered worthless much early work on growth appraisal done in hardwood stands of this type, not only in Pennsylvania but elsewhere. It now becomes necessary to investigate anew all phases of the growth and yield that will characterize our reconstructed forests of the future.

ALTHOUGH a number of forest types are recognized as occurring in Pennsylvania, two of them, the beech-birch-maple and oak-chestnut-hard pine, together comprise the major portion of the timber land in the State. Formerly it was our extensive stands of white pine and hemlock that were most valuable and which at one time supplied about three-fourths of the lumber cut. Clear cutting and devastating fires have so modified the forest composition that now Pennsylvania's second growth woodlands are probably ninety per cent hardwood. This predominance of hardwoods, although admittedly containing some regrettable features, may from other viewpoints be a rather fortunate situation.

Importance of Hardwoods

Because of the long time usually required to grow a crop of timber to maturity, foresters are prone to concentrate attention upon the faster growing species, particularly conifers. There is no question but that from the standpoint of volume production alone most conifers hold a decided advantage. Hardwood products, on the other hand, fill a specialized field of usefulness in which softwoods cannot compete, thereby often commanding a sale price that more than compensates for their slower growth.

Mature hardwood timber of good quality is becoming so scarce that a fair market exists for all that is available, even during these times of depression. Recent studies (11) have shown that, notwithstanding the general drop in timber values throughout the United States from 1923 to 1930, there has been during this period a marked upward trend in the prices of both hardwood stumpage and logs. To owners of immature timber, burdened with taxes and hard pressed to meet financial obligations, this fact in itself should offer considerable encouragement.

If our eastern states are ever again to assume an important position in lumber production, it is logical to presume that the key to the solution must rest largely with the management of existing hardwood forests. Just as the South and West offer most promise for softwoods, so the eastern and central states, with the

[1]Presented at the annual winter meeting of the Allegheny Section at Philadelphia, Pa., February 24-25,, 1933

southern Mississippi Valley extension, hold practically a monopoly of the nation's available hardwood supply. Then, too, this populous eastern region, in addition to furnishing the center of consumption, contains also the principal manufacturing centers of the furniture, veneer, automobile, and farm machinery industries, a rare combination of conditions conspiring to make forestry with our hardwoods economically feasible.

The Oak-Chestnut-Hard Pine Type

Of Pennsylvania's 13,000,000 acres of forest land, it is conservatively estimated that one-half or more of this vast area is included under what we term the oak-chestnut-hard pine type. Most notable exceptions include the northern tier counties, wherein the beech-birch-maple forest predominates, and the more or less scattered distribution of fragments of the white pine-hemlock type. The four or five additional types (6), recognized as occurring in Pennsylvania, are of only local importance and cover in the aggregate but a small fraction of the total forested area.

No other forest type within the State is so widely distributed as the oak-chestnut-hard pine; nor is any other marked by such extremes of soil moisture and fertility. Besides predominating in the farm woodlots within the valleys, it clothes the steepest slopes and most barren ridges with a protective cover of timber.

Throughout our oak forests there is abundant evidence, particularly in the mountainous sections, of the abusive methods of exploitation used in removing previous crops of timber. Repeated clear cuttings and fires have resulted in even-aged sprout forests, in which defective trees and inferior species often prevail. Such conditions are most typical of extensive areas where charcoal operations once centered. Young and middle-aged forests everywhere predominate, with mature timber extremely scarce; most stands are understocked.

Foresters are well acquainted with the principal trees found in this association. They comprise mostly our five common species of oak, chestnut, red maple, hickory, black locust, sassafras, black gum, birch, and aspen, while often on the slopes and ridges are intermixed pitch, table mountain, Jersey scrub, and, in some localities, shortleaf pine. Changes in soil and moisture give rise to an infinite variety of mixtures or sub-types, not to mention intergradation with other major types along their transition zones. Just where to draw the line in defining the limits of any forest type is indeed a difficult task and a problem over which foresters and ecologists have always pondered. Also no definite agreement exists concerning nomenclature of some of our most common tree associations. Thus what we choose to call the "oak-chestnut-hard pine" type is commonly referred to as "oak-hickory," "sprout hardwood," and "chestnut-rock oak-pitch pine" by various writers.

Value of Yield Studies

Yield studies serve a variety of useful purposes. First of all, they offer a basis for estimating the value of standing timber, in terms of either its present or predicated future yield. Knowing the expectation value for different products at any period in the life of the stand, the owner can determine what rotation best serves his interests. If the stand is entirely or partially destroyed, as for instance from fire, disease, or illegal cutting, it is possible to render a fairly accurate appraisal of the damages. In case of reforestation, comparative yield studies offer assistance in assessing site quality and in arriving at proper choice of species. Other uses include forest taxation studies and determining advisability of thinnings. It is well known that the

success of any plan for sustained yield management rests largely on comprehensive studies of growth and yield. In short, "an accurate or even an approximate knowledge of yields per acre and the average rate of growth per year tends to place forestry on a business basis rather than one of blind speculation" (1).

Scope of Present Study

During the past year or more the writer has been engaged in a growth and yield study covering the oak-chestnut-hard pine forest type in Pennsylvania. It is emphasized that the data and discussion presented here are not final. Not only are the data incomplete, in that they do not cover all sites, but what are given will probably require some modification when a larger mass of information has been assembled. Although the evidence at hand shows certain well defined trends and is believed to approximate closely to average conditions, definite conclusions must await further research.

Guiding Principles Observed

Before field work could proceed certain guiding principles had to be formulated. It was early decided that plots should be located only in fully-stocked stands and that the stands selected should be essentially even-aged in character. Thus the purpose of the study is to determine the capacity of different sites to produce the greatest possible yield under most favorable conditions of stocking. A minimum of 100 plots was determined upon as a necessary basis from which reliable conclusions might be drawn, subject to statistical tests in the final analysis. These plots were to be so distributed throughout the state as to include the full range of growth possibilities within the type; in other words, all age classes and sites were to be represented, insofar as possible. Stands containing more than ten per cent chestnut, on the basis of volume, are excluded from consideration.

Stand Composition

In constructing a yield table for such a mixed type as the oak-chestnut-hard pine, there are two methods of dealing with variation in composition. Considered from one standpoint, separate tables should be constructed for each important species, on the basis of pure fully-stocked stands. This first method, in practical application to a particular tract, would necessitate determining the percentage of each species present and multiplying by the corresponding values in the various yield tables, these sums to be then added and adjusted by the factor of density (1.0 to 0.0). In applying separate tables on this basis to get yields for the future from young mixed stands, the question of survival may modify results, in case one species should tend to crowd out another. Other objections are the time and cost involved in constructing separate tables for so many individual species.

Another approach, and the one that has been followed in this study, is to assume that species of similar growth habits will, when growing in mixture, behave very much like a pure stand. That this is particularly true of the oaks is demonstrated by the fact that volume tables covering five different species, constructed at the Pennsylvania Forest Research Institute, show a decided similarity of values. Additional proof, as presented in Table 2, is afforded by the slight variance in height and diameter growth made by our different oaks when growing together on average quality sites.

For even-aged mixed stands in this type it was decided to prepare one composite yield table, based on data representing the great variety of mixtures such as usually occur under natural conditions. As more intensive forest management is

demanded additional refinements in yield studies will be justified.

Basis for the Study

To date, about 50 study plots have been established in the nine counties of Franklin, Adams, Fulton, Bedford, Cumberland, Huntingdon, Perry, Mifflin, and Juniata, all located in central and southern Pennsylvania. Of this number, volume calculations have been completed on 40 plots which form the basis for the tabular data presented in this paper. They represent age classes ranging from 15 to 150 years, elevations from as low as 750 feet up to almost 3,000 feet, and sites varying from the very best of cove and valley soils to rocky sterile ridge tops. Plot areas vary from a tenth acre to a full acre, the size depending on such factors as the age and uniformity of the stand. Practically all of these plots are of recent establishment, since the loss of chestnut from permanent plots of long standing has decreased their value for normal yield study.

Plot Selection and Measurements

In yield study work we are obliged to locate sample plots in stands which, through a fortunate combination of circumstances, have become fully-stocked. In the field this condition is seldom encountered, and then only in small areas in any one locality. It therefore becomes necessary to conduct a thorough search in order to find desirable study areas.

The plots, when located, are surveyed with open-sight compass and tape, their shape being generally rectangular. Boundaries are located so as to exclude blanks or openings, thus enclosing a comparatively complete crown canopy. Substantial wooden or stone corners are set and the lines brushed out. White dots are painted at breast height on all live trees within the plot. In numerous cases on state lands the trees are given serial numbers. Growth measurements consist of diameter and height of all trees over one inch, which data are tallied by species and crown class. Age of the stand is determined by averaging ten or more increment borings taken from dominant trees. In addition, there is filled out for each plot a detailed description sheet giving all pertinent information concerning the stand and site.

In computing the wood volume of plots the writer used volume tables that had been previously constructed at the Research Institute. These volume tables, based on taper measurements of 1,700 individual trees, cover the oaks and red maple in terms of total cubic foot, merchantable cubic foot, and board foot volumes. For other associated species, usually of minor representation on most of the plots, form factors were employed in arriving at their respective volumes.

Discussion of Data

The different classes of data in Table 1 represent average and curved values for fully-stocked stands of medium site quality in south central Pennsylvania. Medium site quality corresponds to a site index of 56 feet in height attainable by dominant trees at 50 years of age. The figures illustrate only what growth can be expected from ordinary sites and give no hint of what the very best or the poorest soils can produce.

The average composition of the 40 basic plots was determined from analysis of their cubic foot volumes by species. This summary revealed that 78 per cent of the volume of all plots taken together consisted of oak, while 20 associated species contributed the remaining 22 per cent. The different oaks were represented as follows: rock oak, 32 per cent; scarlet oak, 16 per cent; red oak, 13 per cent; white oak, 12 per cent, and black oak. five per cent.

Trees Per Acre

It will be noticed in Table 1 that up to an advanced age the average acre of oak-chestnut-hard pine forest supports a relatively large number of trees one inch and over in diameter. Therein is reflected a characteristic growth habit of this type. Many stands have an understory of small tolerant trees, principally red maple, which swells the number of individuals per acre but adds little to the total volume growth. Light surface fires thin out the subordinate stand, but often the succeeding sprouts occur more densely than previously, giving rise to the two-storied type of forest. Just how many of these intermediate and suppressed trees can survive depends largely on the density of the dominant crown canopy. As a general rule, stands that are actually normal are not characterized by a dense understory.

Number of trees per acre is a quite variable factor in yield study, even within stands characterized by closed crown canopies. Thus, it is possible for an understocked plot containing trees with corresponding large diameters and crown spread, to contain more wood volume per acre than a more fully stocked stand of the same age. Therefore, in selecting plots for field measurement it is necessary to make due allowance for this by some liberality in determining what constitutes good stocking (10).

It is believed that open forests will, with increasing age, gradually approach full stocking in number of trees per acre for a given site. But to date few comprehensive studies have been made of the rate of progress toward normality within any forest type. Such information can only be secured from permanent sample plots of long standing.

Basal area is generally accepted as a better criterion of normal stocking than number of trees per acre. However, in selecting plots that are to be representative of normal conditions, the investigator has but little to guide him except personal judgment. In the final analysis this judgment may be checked by determining coefficients of variation and rejecting plots not meeting this statistical test. The method followed in this study was to select plots whose crown canopies were as complete as seemed consistent with age, and which showed in addition an even distribution of dominant trees. But not until the data are finally assembled in the office is it possible to weed out those plots that are abnormally stocked. It would appear to be very desirable in yield study work if some simple yet accurate statistical field index for judging normal stands could be evolved.

Height Growth

Our preliminary yield data, taken from 40 representative areas, would indicate that the greater portion of height growth is made during the first 60 years of age, up to which time an annual increase of a foot or more per year is maintained by dominant trees. After the sixtieth year height growth decreases rapidly and beyond 100 years it is merely nominal.

It is surprising to note how very early in the life of the stand the rate of height growth culminates. At some time prior to 30 years of age the periodic annual increment falls below the mean annual increment.

Diameter Growth

On medium sites, the rate of diameter growth culminates at 30 years of age, shortly after culmination of height growth. Dominant trees in fully-stocked stands make their most rapid diameter growth between the ages of 20 and 50 years, during which time the average rate of increase is 0.19 of an inch annually, or

about one inch in five years. Periodic annual diameter growth amounts to nine rings per radial inch when the stand is between 20 and 30 years of age, then decreases gradually until at 90 to 100 years, there are an average of 20 rings per radial inch of current growth. However, growth in diameter is well sustained, even up to 100 years of age. Forest management can of course maintain better diameter growth to a greater age by proper thinning practice.

Comparison by Species

In Table 2 there is an attempt to show a comparison of height and diameter growth of the common Pennsylvania oaks. It is based on averages for dominant trees taken from 40 fully-stocked sample plots. The data, although insufficient to be conclusive, suggest certain interesting tendencies.

It would appear that the different oaks of the black oak group, when found growing on similar sites, are rather closely matched in both height and diameter growth. White and rock oak, however, show consistently lower values than do red, black, or scarlet. Red oak outstrips the others, being followed in order by scarlet, black, white, and rock oak. Very little difference was detected between black and scarlet oak, with scarlet showing slightly better height growth. Possibly if these species were compared on either the best or the poorest sites the margin of differences between them might be greater than is here shown.

Yield in Wood Volume

Of course the forester and private owner are most interested in knowing the quantity of material and character of product that can be produced by this type of forest in a given period of time, and the age at which the crop should be harvested in order to realize maximum

Table 1

PRELIMINARY YIELD TABLE COVERING AVERAGE SITE QUALITY FOR THE OAK-CHESTNUT-HARD PINE FOREST TYPE IN PENNSYLVANIA[1]

Age of stand (years)	Trees per acre (one inch and over)[2]	Av. d.b.h. (in.) Dom. trees	Av. d.b.h. (in.) All trees	Average height Dom. trees	Basal area per acre (sq. ft.)	Total volume per acre: Cubic feet[3]	Total volume per acre: Cords[4]	Total volume per acre: Board feet[5]	Mean annual increment: Cubic feet	Mean annual increment: Cords	Mean annual increment: Board feet
20	2635	3.6	2.0	29	58	960	16.0	—	48	0.8	—
30	1355	5.9	3.3	40	80	1455	20.9	80	48	0.7	3
40	890	7.6	4.5	49	98	1935	25.8	1800	48	0.6	45
50	655	9.0	5.6	56	112	2335	29.6	3900	47	0.6	78
60	580	10.4	6.2	61	122	2670	33.3	6000	45	0.6	100
70	530	11.6	6.7	65	130	2955	36.6	8000	42	0.5	114
80	490	12.8	7.1	68	135	3210	39.6	9880	40	0.5	123
90	460	13.9	7.4	70	138	3435	42.2	11580	38	0.5	129
100	445	14.9	7.6	71	140	3635	44.5	13000	36	0.4	130

[1]Table is based on 40 growth study plots, located in central and southern Pennsylvania.
[2]Includes merchantable dead standing trees.
[3]Based on Pennsylvania Forest Research Institute volume tables for the oaks and red maple. Volume includes bark, stump, and top (no limbs). Form factors cover other associated species.
[4]Assumes that trees are fully utilized to a 2-inch d.o.b. top (no limbs). Converting factor (cu. ft. per cord) varies with average diameter of the stand.
[5]Based on International Rule (1/4 inch kerf) to a 5-inch d.o.b. top, for trees 8 inches and over.

profit. Any comprehensive answer to such questions must necessarily depend on local conditions. Rate of growth, as expressed in yield tables, varies greatly for different stands according to their age, density, composition, and the quality of the site that they occupy. It is not the purpose of this paper to present data covering the wide range of growth possibilities that actually exist. Rather it is intended to give some hint of what may be expected of normal stands found growing on soils of moderate fertility.

Mixed forests of oak and associated species in Pennsylvania grow rather slowly as compared to conifers (2), but make nevertheless a fair rate of growth. Considering that at 30 years of age a fully-stocked acre yields about 1,400 cubic feet of 21 cords of wood, and that at 70 years this has doubled in quantity and will saw out 8,000 board feet, these forests are worth money to the owner. If left uncut until 100 years of age the yield should approximate 44.5 cords, or 13,000 board feet per acre. Based on 1932 values, a fair stumpage price (11) for such quality timber is $7.00 per thousand feet, so that at 100 years the owner would realize a gross return of $91.00 per acre, plus rather valuable earlier thinning yields. It must be recognized though that growing oak to saw timber size involves a long-time investment, with many hazards. This is particularly true of even-aged forests on poor soils, where the interval between periods of return is so long that maintenance costs may completely absorb all proceeds, unless developed under a yield tax system as is possible in Pennsylvania.

Normal yields in fully-stocked stands of oak and associated species are shown in Table 1. Since understocking is very prevalent in our Pennsylvania forests, these yields would of course have to be discounted in order to be applicable to any specific large areas.

TABLE 2

GROWTH COMPARISON OF THE COMMON PENNSYLVANIA OAKS[1]

Age of stand (years)	Red oak		Scarlet oak		Black oak		White oak		Rock oak	
	D.b.h. (inches)	Height (feet)	D.b.h. (inches)	Height (feet)	D.b.h. (inches)	Height (feet)	D.b.h. (inches)	Height (feet)	D.b.h. (inches)	Height (feet)
20	3.6	32	3.6	29	3.6	29	3.3	28	3.6	26
30	6.2	44	5.9	41	5.9	39	5.5	38	5.6	36
40	8.4	53	7.6	50	7.6	48	7.2	47	7.1	44
50	10.1	60	9.0	58	9.0	56	8.7	54	8.3	51
60	11.5	65	10.4	63	10.4	61	10.0	59	9.4	55
70	12.9	69	11.6	67	11.6	65	11.2	63	10.3	58
80	14.0	72	12.8	70	12.8	68	12.4	66	11.1	61
90	15.1	75	13.9	72	13.9	70	13.5	68	11.8	63
100	16.0	77	14.9	73	14.9	71	14.5	69	12.4	64

[1]Based on averages for dominant trees in 40 fully-stocked growth study plots of mixed oak and associated species located in South-central Pennsylvania. The values are graphed and represent medium site quality for each of the various oaks.

Mean annual growth in cubic feet is highest during the first 40 years of the life of a stand, during which period it averages 40 cubic feet or 0.7 of a cord annually. Thereafter mean annual growth drops off steadily, showing at 60 years about 0.6 of a cord, while at 100 years it amounts to only 36 cubic feet or 0.4 of a cord per acre per year. Board foot production commences at about 40 years of age with a mean annual growth of 45 board feet per acre, then gradually increases, but at a steadily diminishing rate, until at 100 years it about reaches its peak of 130 board feet.

The cubic foot values given here represent total yield of the stand outside bark, including stump and top but not limbwood. Board foot values, based on International Rule (¼-inch kerf), are somewhat high and commence at 30 years because of the fact that trees eight inches and over are included. Added in both are the merchantable dead standing trees that occurred on the plots. The converting factor for cordwood production increases with average diameter of the stand, ranging from 60 cubic feet per cord at 20 years to 82 at 100 years of age.

It should be kept in mind that these figures represent stands growing under present conditions and are therefore only a conservative indication of the possible yields from properly managed forests. The widespread prevalence of forest fires is undoubtedly an important factor contributing to reduced growth of our forests. It is believed too that the yield would be considerably higher if chestnut were still an important component of the stand. Proper thinning should stimulate the rate of growth and even extend the age at which mean annual growth culminates.

Length of Rotation

Table 1 shows that mean annual growth in cubic feet tends to culminate between the ages of 30 and 40 years, when a maximum of 48 cubic feet per acre per year is attained.

A rotation of 30 years would yield such small sized material as to be of little value except for fuelwood or charcoal purposes. At 40 years, however, a considerable quantity of posts, mine ties, and mine props could be harvested, while ten years later standard cross ties and even some smaller sawlogs might be added to the list of products. But rather than cut immature timber during its period of most rapid growth, much the wiser policy would be to withhold cutting 20 years or longer in order to secure quality increment. With oak there is a great increase in value with size, since for the majority of manufactured products it is the heartwood that is most useful.

From the standpoint of commercial value for saw timber, it is the information regarding mean annual growth in board feet that is of most significance as a guide

TABLE 3

CORTARISON OF PENNSYLVANIA YIELD STUDIES FOR DIFFERENT FOREST TYPES[1]

Age of stand (years)	Oak-chestnut-hard pine type (medium sites)[2]	Pure pitch pine (site quality I)[3]	Beech-birch-maple type (medium sites)[4]
	Total volume per acre in cubic feet		
20	960	1566	1200
30	1455	2500	2375
40	1935	3135	3375
50	2335	3872	4025
60	2670	4390	4425
70	2955	4720	4650
80	3210	4880	4800
90	3435	4950	——
100	3635	4825	——

[1]All based on fully-stocked stands.

[2]Values taken from Table 1. Site Index 56 ft. at 50 years.

[3]Taken from Research Bul. 2, Penna. Dept. of Forests and Waters. Site Index 57 ft. at 50 years.

[4]Taken from Bul. 46, Penna. Dept. of Forests and Waters. Site Index 61 feet at 50 years.

to forest management. Apparently the maximum mean annual board foot production occurs at about 100 years. Also the present data suggests that soon after 100 years the periodic annual increment falls below the mean annual board foot increment. This would indicate that 100 years is probably the most desirable age at which to cut saw timber on ordinary sites within this type. On the best sites it will undoubtedly be found that a shorter rotation, possibly 70 years or less, can be justified, while for stands to reach optimum size for lumber on the shallow soils of our steepest slopes and ridges, from 125 to 150 years of growth might be required. But so many other factors than maximum quantity production in minimum time enter into a choice of rotation age that each case must be decided according to the prevailing conditions (9).

Comparison of Pennsylvania Yields

It may be of interest to compare the probable yield of this oak type with published yield tables covering pure pitch pine (8) and also the beech-birch-maple forest type (7) in Pennsylvania. To offer a fair comparison it is obviously necessary to limit discussion to stands occupying similar sites, insofar as possible. This can be best done by taking site quality I values for pitch pine, while for beech-birch-maple forests the average growth figures published are most applicable. Based on height attainable at 50 years of age, oak then shows a site index of 56 feet, pitch pine, 57 feet, and beech-birch-maple, 61 feet. A comparison of their cubic foot yields by ten-year periods is presented in Table 3.

Pure, fully-stocked stands of pitch pine show a rate of growth averaging over 50 per cent faster than those composed of oak and associated species. This holds true up to about 90 years of age, after which pitch pine forests break up and deteriorate rapidly. Beech-birch-maple forests too, not only in Pennsylvania but in other regions as well (3), appear to grow at a rate somewhat superior to the oak-chestnut-hard pine type. Pitch pine timber on the best quality sites produces a yield in cubic feet that up to 90 years compares very favorably with that of average beech-birch-maple stands in northern Pennsylvania.

Table 4

YIELD OF OAK-CHESTNUT-HARD PINE TYPE IN PENNSYLVANIA COMPARED WITH OTHER REGIONS

Age of stand (years)	Pennsylvania[1] Oak-chestnut-hard pine type (medium sites)	Connecticut[2] Oak type (site quality 3)	Connecticut[2] Oak-chestnut type (site quality 3)	Vermont[3] Northern hardwoods (site quality 2)	Illinois[4] Upland hardwoods (medium sites)
	Total volume per acre in cubic feet				
20	960	640	....	922	810
30	1455	1260	1500	1435	1175
40	1935	1770	2070	1949	1520
50	2335	2210	2500	2525	1870
60	2670	2550	2850	2920	2175
70	2955	2830	3130	3220	2500
80	3210	—	—	3475	2825
90	3435	—	—	—	3125
100	3635	—	—	—	3425

[1]Values taken from Table 1. Site Index 56 feet at 50 years.
[2]Taken from U.S.D.A. Bul. 96. Site Index for oak type is 52 feet at 50 years; for oak-chestnut, 58 feet at 50 years.
[3]Taken from Vt. Agr. Exp. Sta. Bul. 176. Site Index 54 feet at 50 years.
[4]Taken from Ill. Nat. Hist. Surv. Bul., Vol. 17, art. 2. Site Index 61 ft. at 50 years.

Comparison with Other Regions

Our data given in Table 1 enable the growth of mixed oak stands in Pennsylvania to be compared with other regions where this type or a similar type of forest occurs. The yield tables which will be used for this purpose are those of Frothingham (4) for Connecticut, Hawes (5) for Vermont, and Telford (12) for Illinois. Table 4 brings out this comparison on the basis of cubic foot yields attainable at different ages.

As suggested by Table 4, forests of mixed oak and associated species show very similar growth on comparable sites in Pennsylvania, Connecticut, Vermont, and Illinois.

These points of similarity between the present study and other work do not necessarily prove anything, though they indicate that our preliminary growth and yield data, derived for oak-chestnut-hard pine forests in Pennsylvania, are at least relatively correct.

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BRIEFER ARTICLES AND NOTES

Second Conference on Article X

The second conference on Article X of the Lumber Code, originally planned for mid-December, has been postponed until January 25-26, in order to give the divisional agencies of the Lumber Code Authority more time and a better opportunity to discuss their problems and to formulate their recommendations for divisional codes of woods practice.

The first 3 days of the week, January 22 to 24, will be available for preliminary meetings of the 6 conference committees, subject to the call of their chairmen.

American Forestry Association Honors Silcox

Foresters and conservation leaders in Washington welcomed the opportunity to meet F. A. Silcox, the newly appointed Chief Forester, who succeeds the late Robert Y. Stuart, at a smoker and reception on the evening of December 6 in the home of Ovid Butler, executive secretary of The American Forestry Association. Mr. Silcox, who was introduced to the many guests by Mr. Butler, found himself swung rapidly from discussions of national forest management to erosion control, subsistence homesteads, more attractively printed forestry bulletins and the prospects for forestry in the coming session of Congress. It afforded an unusual opportunity for men in the several government services to exchange ideas among themselves, to meet representatives of various non-government organizations, and gave the officers of The American Forestry Association suggestions for furthering its services to forestry.

Among those present were members of the Washington office of the Forest Service, representatives of the National Park Service, Paul G. Redington of the Biological Survey, Knowles Ryerson, newly announced Chief of the Bureau of Plant Industry, H. H. Bennett of the Soil Erosion Control Service, Dr. C. W. Warburton of the Agricultural Extension Service, Ward Shepard of the Indian Service, Verne Rhoades of the Public Works Administration, and a number of Army and Navy officers. With these were Dean Henry S. Graves of the Yale Forest School, Dr. John C. Merriam of the Carnegie Institution, Dr. Cloyd Heck Marvin of George Washington University, Dr. Wilson Compton and others from the National Lumber Manufacturers' Association, Franklin Reed of the Society of American Foresters, Robert Sterling Yard of the National Parks Association, Seth Gordon of the American Game Association, Percival S. Ridsdale of the American Tree Association, Albert W. Atwood of the editorial staff of the *Saturday Evening Post,* James P. Hornaday of the *Indianapolis News,* Frank Thone of Science Service, and others.

National Afforestation in Germany

Strange is it to learn that Germany, the home of reforestation, has taken a leaf out of the book of New York State's Reforestation Program and has inaugurated a National Plan for Afforestation—

with a slogan: "Wastes shall become Woods" ("Oedland Wird Wald!").

According to "Der Deutsche Forstwirt" for 29 September of this year (Vol. 15, No. 78) Minister of Agriculture Darré has issued an order whereby wide areas of barrens will become forests. This is to be done to lessen unemployment under the law of 1 June, 1933. The work is to be done by public and private landowners; the credit is furnished by the state through the Deutsche Rentenbank-Kreditanstalt in Berlin. Loans are to bear 3 per cent interest; after three free years they are to be amortized at 2 per cent annually and must be fully repaid in 31 years. In addition, there is an annual administration charge of one fourth of one per cent. This credit may only be expended for soil preparation, for seed purchase, for nursery and for planting expenses, including fencing. Not over 40 working hours a week are allowed hired labor; voluntary labor is limited to 36 hours a week. The work must begin immediately and be completed by July 1, 1934. The areas to be afforested include heathland, sub-marginal farmland, and areas formerly in forest but destroyed by insects, fire, storm, etc. In starting these new forests, formations especially subject to calamities (storm, insects, fungi) are to be avoided, *particularly pure coniferous forests* (the italics are mine A.B.R.). The aim in all cases shall be a mixed forest, not confining the choice to a few species but including species not indigenous to Germany or those not sufficiently represented therein, such as: mountain maple, ash, mountain elm and blue beech; also, in suitable sites walnut and chestnut. Especial consideration is to be given the softer hardwoods ("step children of forestry") such as basswood and Canadian poplar (aspen).

Adequate means of fire protection through fire lines, bands of broadleaf trees, etc., are required.

In "Der Deutsche Forstwirt" for 10 October (Vol. 15, No. 81) Dr. Wrabec follows this with a proposal for communal reforestation projects ("Aufforstungsgenossenschaften") and points out the means whereby small landowners (farmers) can take advantage of these credit provisions by forming "co-operatives," to function under state supervision. The employment of a trained forester to administer these coöperative farm forests ("Waldgenossenschaft") is obligatory. A complete sample charter form is appended.

A. B. Recknagel,
Cornell University.

A Recording Shrinkage Meter for Wood and Other Materials

The shrinking and swelling of wood is a serious handicap to its utility as a material in a number of the most important uses for which it is employed. Furniture, interior finish, flooring, doors, and window sashes, are cases in point. In these and many other comparable uses of wood expense and annoyance are consequent upon the shrinkage and swelling which parallel outgo or intake of moisture occurring as a result of variations in the relative humidity and temperature of the surrounding medium.

Following best practice in design and construction, using appropriate wood species, and conditioning the lumber and fabricated articles to a moisture content proper for the particular use, go far towards obviating or minimizing the difficulties arising from the hygroscopic nature of wood. Nevertheless, evolving effective and economical methods of reducing the "working" of wood is one of the

principal problems confronting the timber researcher.

In the course of work on this problem the need was felt for an apparatus which would measure, and automatically record, both the amount of shrinkage or swelling undergone by test specimens and the time occupied by these processes under known conditions. The apparatus represented in Figure 1, devised to perform these functions, has given generally satisfactory results and may be of interest to others who require to make and record measurements of a comparable character.

The meter is primarily intended for use with pairs of "end-matched" or "side-matched" test pieces. That is, pieces so cut that the wood comprising one member of any pair grew end to end, or side by side, with that of the other member. In any pair, one test piece is processed or treated in some way, the other being an untreated control. Both pieces would, as a rule, be in a similar condition as to moisture content at the beginning of a determination. The instrument may also be used for measurements on two test pieces related to each other in some way other than the above, and the behavior of which, in shrinkage or swelling, it is desired to compare. The meter may be set up in a constant temperature-humidity chamber or otherwise.

The test pieces 1, 1, are placed on the shelf, or slide 2, in contact with the fixed block 3. The adjustable guides 4, 4, pre-

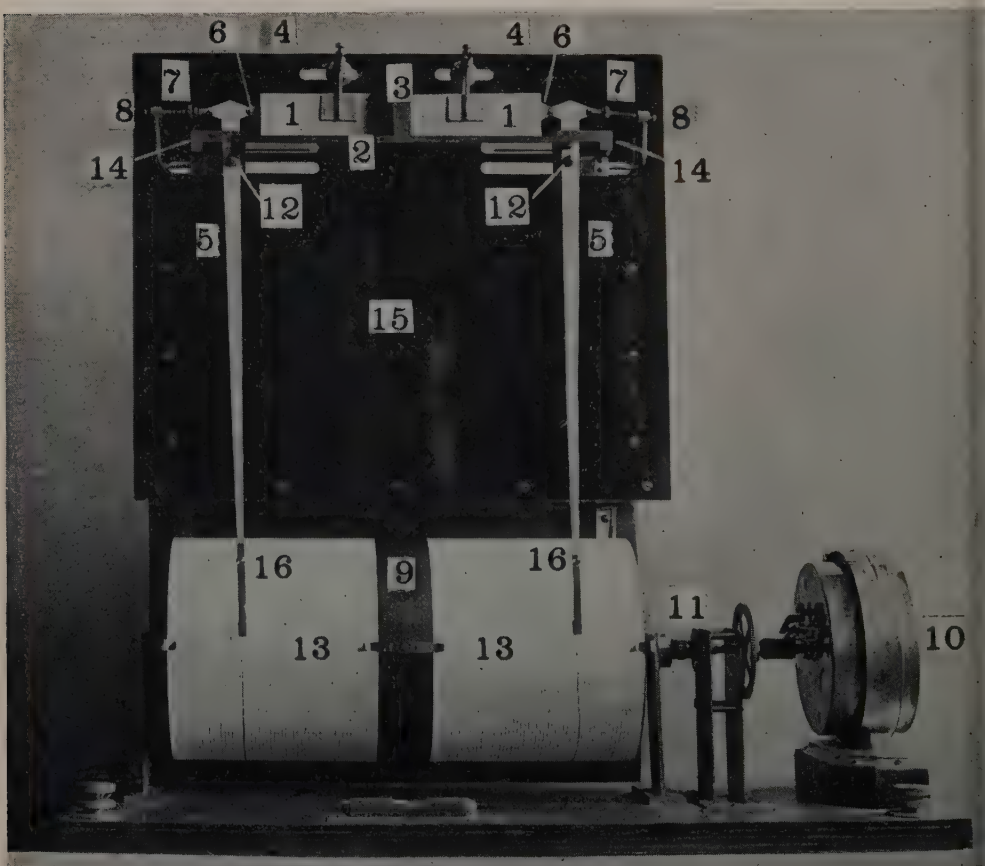

Fig. 1.—Recording shrinkage meter for wood and other materials.

vent lateral displacement of the test specimens and insure that all shrinkage or swelling movements take place in a straight line. Pieces which warp or become distorted during a test are discarded. The pen arms 5, 5, are adjustable in a horizontal direction, permitting the use of test pieces from two to four inches in length. These arms make contact with the test specimens by means of pivoted fittings 6, 6, which allow free movement of the pen arms. The small springs 7, 7, exert sufficient pressure to maintain proper contact of these fittings with the test pieces. Pressure is variable by means of the set screws 8, 8.

The cylinder 9 is rotated by the clock 10, through gearing 11, so designed that the cylinder makes one complete revolution every 24 hours. Other rates of rotation can of course be obtained by changes in the gearing.

The proportions of the pen arms, above and below the pivots 12, 12, are such that movements due to shrinkage or swelling of the test pieces are enlarged nominally ten times. These movements are recorded on the charts 13, 13, which are ruled with vertical and horizontal lines. Travel of the pen from one vertical line to the next represents a shortening or elongation of the test pieces of nominally .01 inch. Travel from one horizontal line to the next represents the passage of one hour.

At the beginning of a determination the pen arms are set at zero by bringing them to the exact vertical position. This is accomplished by adjusting so that a vertical line on the upper part of each pen arm coincides with a vertical on the fittings 14, 14.

The upper part of the instrument 15 is hinged to the vertical portion of the stand and can be turned back, removing the pen arms from the normal position shown in the figure and allowing unobstructed access to the cylinder. The latter can then be lifted entirely out of its bearings, thus facilitating the removal of used charts and the attaching of new ones.

The measurements recorded on the chart deviate slightly from true readings. When the pen arm moves, due to shrinkage or swelling of the test piece in a horizontal direction, the upper part of the arm does not move in an exact horizontal line but describes an arc about the center formed by the pivot 12. Similarly the lower portion describes an arc about the same center. By making the necessary adjustments in the length of the lower parts of the pen arms, by means of the set screws 16, 16, the chart reading for a movement of .01 inch (in the test piece) starting from zero, can be made exactly .1 inch. Subsequent movements of similar magnitude will appear on the chart as enlarged very slightly less than ten times and will therefore involve a small error which increases as the distance from the zero position becomes greater. As, however, the change of dimensions in test pieces of the size employed usually does not exceed a few hundredths of an inch at most the errors referred to are quite negligible for most work and certainly do not exceed observational error in reading to thousandths of an inch.

Various methods of testing or proving the instrument may be used. In one method the pen arm on one side is removed and a specially made screw is inserted in a threaded hole in the fixed block 2, the hole being so bored that when the screw is in place it travels horizontally when turned. The remaining pen arm is set at zero, the screw being turned until it is in contact with the pivoted fitting 6. An Ames dial, reading in hundredths of an inch, is connected with the screw, the latter being free to revolve.

The pen itself rests on a thin scale graduated in hundredths of an inch and previously attached to the cylinder by

means of the chart clips. This scale is placed in a horizontal position. The screw is turned through successive distances of one hundredth of an inch and the distance traversed by the pen on the scale is noted each time. The direction of travel of the screw is then reversed and readings again taken. By repeating this process several times the slight errors in the chart readings can be easily determined and the necessary allowances made. As previously stated, however, this is unnecessary for ordinary work.

The meter is suitable for determinations on a variety of hygroscopic materials and slight modifications in design further widen its field of usefulness.

W. Kynoch,
School of Forestry and Conservation.

Logging Damage in Selectively Logged Loblolly Pine Stands

Many recent publications have dealt with the economic and some with the silviculture of selective logging, but few have presented data on the damage done to the residual stand during the various operations of logging. This paper presents such data collected in connection with two selective logging studies in loblolly pine (*Pinus taeda,* Linnaeus) stands in the Mid-Atlantic Coastal Plain by the Appalachian Forest Experiment Station and the Forest Products Laboratory.

During 1929 and 1930 six one-acre plots were established in a forest-grown stand of loblolly pine and hardwoods in southeastern Virginia, and four two-acre plots were established in an old-field stand of loblolly pine in eastern North Carolina. The areas appeared to be fairly representative of these two forest conditions in the Mid-Atlantic Coastal Plain. The forest-grown stand contained 111 pines and 222 hardwoods, over three inches d.b.h. per acre, and the old-field stand included 188 pines and 149 hardwoods per acre. In the forest-grown stand 21 per cent of the pines and 6[illegible] per cent of the hardwoods were over 14 inches in diameter, while in the old-field stand only 16 per cent of the pines and 1[illegible] per cent of the hardwoods were over 14 inches.

The forest-grown stand was marked for cutting following a plan which called for the removal of all mature, overmature, and poorly formed loblolly pine trees and all merchantable hardwoods. This marking planned the removal of from 48 to 50 per cent of the stands, by basal area, on the plots.

In the old-field stand the primary aim of the marking was to remove sufficient volume to make logging practicable, favor loblolly pine, and provide for a future cut. The proportion of the stand removed from the plots ranged from 46 per cent to 68 per cent by basal area.

All plots were cut over by the regular woods crews of the coöperating companies and the logs were horse-skidded to central points and then hauled to railroad spurs on high wheeled wagons. Following logging all trees over 2.5 inches d.b.h. were examined and the injuries noted in the three following classes:

1. Damage associated with felling from which trees will not recover. This category included trees which, to the observer, appeared to have little chance of surviving, such as trees which had been uprooted or from which the majority (60 per cent +) of the crowns had been broken.

2. Removal of trees for roads and skidding trails, and to facilitate felling.

3. Damage associated with felling from which trees apparently will recover. This included trees which were scarred or from which less than 60 per cent of the crown had been broken.

The classification of individual trees was in many cases, necessarily arbitrary and it will be several years before the accuracy of estimates of recovery is known.

The average expected residual stand[1] after cutting on the forest-grown plots included 62.5 per cent of the loblolly pines and 91.5 per cent of the hardwood trees, and 59.3 per cent of the loblolly pines and 90 per cent of the hardwoods on the old-field area. The expected stand was not obtained, however, on any of the ten plots because a number of trees designated for reservation were damaged beyond recovery or cut during the logging operation.

Table 1 summarizes the data for the three kinds of injury on the two groups of plots. Here it is apparent that the average number of loblolly pines per acre damaged beyond recovery (Class 1) was relatively small on both groups of plots. The variation between plots, however, was quite large; the forest-grown plots contained from 2 to 10 trees per acre in this class and the old-field plots from 6 to 11 per acre.

It is also evident from Table 1 that on the forest-grown plots many more hardwoods than pines were damaged beyond recovery, the number ranging from 7 to 24 per acre. On the old-field plots the range was much more restricted, the number in this class varying only from 3 to 8.

The number of pines cut to clear roads, bunching trails, etc., (Class 2) was very small, ranging only from 0 to 2 trees per acre on all plots. The hardwoods, however, suffered far greater losses, the number of trees removed in this phase of logging ranging from 19 to 37 per acre on the forest-grown plots and from 7 to 28 per acre on the old-field plots.

The number of loblolly pines which were injured only slightly (Class 3) is in most cases large enough to be important, especially on the old-field plots where the number so injured ranged from 4 to 14 per acre (from 4.8 to 9.8 per cent of the expected residual stand of loblolly pine.) More pines suffered slight injuries on the old-field than on the forest-grown plots because the larger number of trees reserved per acre made it more difficult to fell trees without injuring those left standing. On all plots except one the number of hardwoods injured was materially greater than the number of pines.

In most of the classes of injury the percentage of the expected residual stand of hardwoods injured was greater than the corresponding percentage of pines. This was probably due in part to the attempts of the woods crews to save the pines in contrast to their utter disregard of hardwoods, which were considered undesirable components of the stands. This attitude regarding the hardwoods is difficult to jus-

[1]All trees not marked for removal.

TABLE 1

SUMMARY OF LOGGING DAMAGE TO EXPECTED RESIDUAL STANDS

Class of damage	Forest grown				Old-field			
	No. of trees per acre		Per cent of residual stand[1]		No. of trees per acre		Per cent of residual stand[1]	
	Loblolly pine	Hardwoods	Loblolly pine	Hardwoods	Loblolly pine	Hardwoods	Loblolly pine	Hardwoods
1. Damaged beyond recovery	4.8	12.5	6.8	6.3	7.8	5.5	7.0	4.1
2. Removed incident to logging	0.9	26.2	1.2	12.9	1.5	17.0	1.3	12.7
3. Injured slightly	2.8	32.5	4.0	16.0	11.5	30.2	10.3	22.5

[1]Percentages computed on basis of expected residual stand in separate species groups.

tify at the present time, except on an economic basis, because little is known regarding the silvicultural value of hardwoods in loblolly pine stands.

In general, the percentage of the expected residual stands in each of the three injury classes on all plots increased with the severity of cutting as indicated by the percentage of the original basal area removed in cutting. The correlation was not pronounced but can logically be viewed as real, although many other factors were operative.

A. L. MacKinney,
Appalachian Forest Experiment Station.

Cover Type as a Factor in Forest Fire Protection

An analysis made of Michigan forest fire reports for the years 1928 to 1932, inclusive, shows that, for the state as a whole, only 0.9 per cent of the area burned was merchantable timber while 47.3 per cent was second-growth and 51.8 per cent was non-timbered. The most significant fact brought out, however, is the preference of fires for aspen-birch second-growth and grass plains, the former making up 25.2 per cent and the latter 30.4 per cent of the area burned. While this is largely due to the prevalence of these types, the analysis in question serves to point out where the bulk of the protection problem lies. The figures by types are given in Table 1.

Table 1

DISTRIBUTION OF AREA BURNED BY COVER TYPES MICHIGAN—1928-32

	Per cent	Per cent
Merchantable timber		0.9
Second-growth		47.3
White and Norway pine	0.8	
Jack pine	3.7	
Mixed hardwoods	8.0	
Oak	5.9	
Aspen and birch	25.2	
Swamp timber	3.7	
Non-timbered		51.8
Grass plains	30.4	
Grass swamp	11.9	
Fresh slash	8.5	
Pasture and hayland	0.9	

Based on the best figures available as to the area of the various types under protection, the per cent of each type burned over on the average in Michigan is shown in Table 2.

Table 2

TYPES BURNED OVER IN MICHIGAN

	Per cent	Per cent
Merchantable timber (all types, including sawtimber and cord-wood stands)		0.04
Second Growth (all types)		0.64
Pine	.89	
Northern hardwoods	.50	
Oak and oak-hickory	1.00	
Aspen	.73	
Swamp timber	.28	
Non-timbered (all types)		1.74
Upland	1.59	
Swamp	2.68	
All types combined		0.79

These figures are of particular interest in that they show the risk of burning or relative hazard prevailing in each of the types in question. They may also be taken as indicating the effectiveness of present protective effort by types.

At present Michigan is spending on the average 3.5c. per acre for protection. If we can assume that area burned varies inversely with the expenditure for protection on the basis of the above, the outlay necessary to limit the area burned to one-half of one per cent would be as given in Table 3.

On the basis of the above and the area of the various types represented, adequate protection (defined as protection sufficient to limit the area burned to half of one per cent) would cost Wisconsin 5.1c. per acre, Minnesota 5.6c. per acre, and the Lake States as a while 5.4c. per acre. At present, however, Wisconsin is spending 2.8c. per acre and burning over 1.99

TABLE 3

OUTLAY NECESSARY TO LIMIT BURNED AREA

	Cents per acre
Merchantable timber (all types included)	.3
Second-growth (all types)	4.5
Pine	6.2
Northern hardwoods	3.5
Oak and oak-hickory	7.0
Aspen	5.1
Swamp timber	2.0
Non-timbered land (all types)	12.2
Upland	11.1
Swamp	18.7
Or for Michigan as a whole an average of	5.5

per cent of the area protected while Minnesota, with an average annual expenditure of 2.34c. per acre, is burning over 1.65 per cent of the area protected. This would indicate a required expenditure of 11.1 and 7.3c. per acre, respectively, to provide adequate protection. It is evident from this that either Wisconsin and Minnesota are getting less protection per dollar expended or that the climatic hazard in these states is higher than in Michigan. A comparative analysis of weather records will be necessary to settle this point. In the meantime, 5.5c. per acre as the average cost of adequate protection would appear to be conservative.

J. A. MITCHELL,
Lake States Forest Experiment Station.

NOTES ON BLACK LOCUST POD COLLECTION, SEED EXTRACTION, AND SEED CLEANING

The Emergency Conservation work program has brought about increased demands for black locust (*Robinia pseudoacacia* L.) nursery stock to be used in erosion-control planting projects. This demand has resulted in a greatly increased interest in obtaining black locust seed. Consequently, many forestry agencies have found it necessary to supply their needs by collecting and cleaning black locust seed locally.

Tests carried on at Holly Springs, Miss., by the Southern Forest Experiment Station in September, 1933, have yielded information of value to those engaged in obtaining a supply of such seed. This information should be especially useful in planning nursery programs and in estimating the cost of the operations.

Eight black locust trees of varying ages and sizes and growing on several different sites were selected for this study. The entire crop of black locust pods from each tree was collected and data for each tree were kept separate. The seeds were extracted from the pods by beating and flailing, care being taken to obtain all the seed. Two electric fans, set in a position to create a cross-current of air, were used to winnow the seed. This operation removed not only the chaff and foreign matter but also most of the defective seeds.

Accurate measurements were kept of the yields from each tree and of the time taken to collect and extract the seed. These data, as well as the averages, are summarized in Table 1.

Because hand methods were used and because unusual care was exercised to obtain all the seed, the time taken in extracting and cleaning the seed was unusually high. A great variation can be seen in the time required to flail, extract, and clean the seed from individual trees. This variation can be accounted for largely by the fact that the pods from two of the trees (numbers 6 and 7) were not thoroughly dry before flailing. This emphasizes the fact that pods should be thoroughly sun-dried before any seed-extraction operations are attempted.

An average for all trees shows that 21.44 pounds of pods were collected during an 8-hour day by local, inexperienced labor. It takes, on the average, 3.62 pounds of pods to yield one pound of clean seed.

TABLE 1

MEASUREMENTS OF YIELDS AND HOURS

Tree description							Seed yields				Labor—man-hours	
				Crown			Pods		Extracted seed			
Tree number	Age at stump	D.b.h.	Total height	Length	Width	Class	Volume	Weight	Volume	Weight	To collect pods	To flail, extract, and clean seed
	Years	Inches	Feet	Feet	Feet		Bushels	Pounds	Quarts	Pounds		
1	11	3.4	24	18	12 x 12	D	.1	.5	.1	.1	.5	.3
2	11	5.0	28	19	16 x 17	D	.4	3.4	.6	1.1	2.2	2.5
3	13	6.2	42	17	17 x 17	D	.6	5.4	.9	1.4	2.2	1.5
4	16	5.1	25	17	21 x 20	D	.2	1.6	.2	.3	1.5	.5
5	17	6.4	26	14	24 x 23	D	.3	2.6	.4	.6	1.3	.8
6	23	7.8	48	25	22 x 19	D	1.2	12.8	2.2	3.6	4.0	7.0[1]
7	23	9.2	43	31	21 x 23	D	1.4	14.1	2.4	4.0	4.0	12.0[1]
8	24	4.8	41	25	20 x 19	S	.4	4.5	.8	1.3	.9	1.8
		Average for all trees					.6	5.6	1.0	1.6	2.1	3.3

[1]Pods not thoroughly dried and crisp before starting seed extraction and cleaning operations.

Thus, inexperienced laborers can be expected to collect in a day the pods necessary for yielding 6 pounds of clean seed. The total cost of collecting pods, extracting and cleaning seed was 31 cents per pound of clean seed. This cost is high because the extraction of seed from pods that were not sufficiently dried required a proportionately large expenditure of labor.

Although these crude methods of extracting and cleaning seeds were limited to small-scale operations, the data on yields should be a useful index for large-scale operations, where threshing separators or other machines are employed.

C. F. OLSEN,
Southern Forest Exp. Station.

GIRDLING OF PONDEROSA PINE BY SQUIRRELS

The taste of the common red squirrel (*Sciurus Hudsonius*) for maple sap, tree seeds, and terminal buds in pine plantations, is well known. It has often been reported robbing birds' nests and even eating caterpillars and insect egg masses.

Its habit of girdling pines is less commonly known. A. D. Middleton in the *Quarterly Journal of Forestry*, October, 1931, states that the British red squirrel in 1900 caused damage estimated at 10,000 pounds sterling by girdling in Scotch pine plantations on the Novar estates in Ross-shire. He states also that the American grey squirrel (introduced) has been observed peeling sycamore, beech, and other hardwoods.

Girdling by red squirrels of ponderosa pine in the Northern Black Hills occurs from the middle of December until the end of February when the sugar concentrations in the sap are greatest, snow is deep, and other food is scarce and difficult to find. During this period the squirrels peel the bark from the young

ponderosa pines and eat the succulent inner bark and cambium layer.

Peeling is generally limited to stands of the 40-year age class, trees of 4 to 7 inches d.b.h., the main stem being attacked at a point 10 to 20 feet from the top. The stem is usually peeled in a narrow spiral band from an inch to three inches wide and a foot long. The following season either side of this band may be peeled. This pr cess may be repeated annually for as many as five years before girdling of the tree is complete. Mature trees are occasionally attacked, the point of damage likewise occurring 10 to 20 feet from the top. The resulting spike tops are usually attributed to porcupines but the squirrel damage is very characteristic and easily recognized on close observation.

As many as 40 trees in a quarter-acre group have been damaged by a single pair of squirrels. In driving from the overhead crossing at the top of Aztec Hill to the head of Ice Box Canyon, a distance of two miles, one can easily identify 150 squirrel damaged trees without stopping the automobile.

The author has observed squirrels feeding in a similar manner on Jack pine (*Pinus banksiana*) on the Chippewa National Forest in Minnesota.

GALEN W. PIKE,
U. S. Forest Service.

FURTHER NOTES ON THE GERMINATION OF HEMLOCK SEED

In a previous article [Jour. For. 28(6): 853-857, 1930] the writer reported the beneficial effect of after-ripening treatment on the germination of eastern hemlock [*Tsuga canadensis* (L.) Carr.] seed. Subsequent experiments, made in 1931 confirmed these results, but occasional lots of seed of high viability as shown by cutting test, failed to germinate well in spite of prolonged storage at low temperatures. Some samples, showing over 60 per cent sound by cutting test, germinated only 1 per cent or even less, after 6 months in the germinator at 24°C. Seed stratified at 4°-10°C. for 1-2 months averaged double as high germination after 30 days, three times after 60 days, and nearly four times after 90 days, as untreated dry seed. These averages are based on a total of 76 tests of 100 seeds each made from 1926 to 1931 and including samples from five different seed crops and several different origins.

Since many samples germinated very poorly, even when after-ripened, some preliminary experiments were made in order to find the cause, if possible. The rate of moisture absorption was determined by placing a weighed quantity of dry seed in a Gooch crucible and soaking it in tap water at a temperature of 24°C. At intervals the crucible and contents were removed, suction applied for exactly one minute to remove excess water, and then immediately reweighed. Moisture absorption began promptly, as might be expected with the thin, soft seedcoats of this species. A gain of 20 per cent occurred in 16 hours and 30 per cent in 48 hours. After three days the seed had increased 32 per cent in weight, and remained constant thereafter. There would thus seem little doubt that the seed absorb water promptly under ordinary germination conditions.

Catalase activity was determined for six samples of dry seed and the same samples which had been stimulated by placing in the germinator for four days. Fifty seeds were used in each test, which was run in duplicate. Seed from the last crop, after becoming imbibed in the germinator, showed an increase of 20 per cent in catalase activity over dry seed controls, while older seed, with one-half as high germinative energy, made no increase. It would thus appear that catalase activity rises promptly with water

absorption. Failure to germinate may depend upon chemical changes which proceed at a slower pace, or upon immaturity of the embryo.

The effect of different germination temperatures was investigated by incubating 3×100 seeds each on agar in petri dishes at 25°-32°C., 24°C. constant, and 15°-20°C., one series without stratification, and another series of the same number of seeds after stratification. Both treated and untreated seed germinated most rapidly and completely at 24°C. Tests were run for six months without germination being completed. In one case 76 per cent of the sound seed germinated in 80 days.

Germination was studied in Jacobsen and Stainer germinators, on agar, sand, peat and filter paper in petri dishes, in soil flats and in nursery beds. Best results were obtained on agar. Soil flats and field tests were subject to undetermined temperature and moisture fluctuations. Relatively good germination was obtained in the nursery, possibly just because of these fluctuations in moisture; it is indicated, at least, that hemlock seed are sensitive to injury from excess moisture.

While the exact cause of sluggish germination was not made apparent from these tests, it is probable that differences in the degree of maturity of different crops, or previous treatment of the seed during collection, extraction and storage may be partly responsible for the erratic germination of this species. Unfortunately lack of space prevents publication of the detailed tables of results.

Henry I. Baldwin,
N. H. Forestry Dept.

The Development and Control of Pine Beetle Epidemics

While the development and control of western pine beetle infestations in virgin, mature ponderosa pine timber have been widely discussed for many years, but scant attention has been paid to the possibility of infestations in the reserve stands of thrifty young trees that are left by the most approved selective logging methods as practiced on national forests and Indian reservations.

Foresters have assumed that the preferred hosts of the beetles are largely the mature and over-mature trees of slow growth and that beetle loss and control problems will largely disappear with the harvesting of this mature timber. Such is undoubtedly the case under ordinary conditions, but during the past year (1932) a situation developed in the reserve stands of ponderosa pine on the cut-over lands of the Klamath Indian Reservation in southern Oregon that furnishes abundant proof that the beetles are sometimes sufficiently aggressive and abundant to attack and kill large numbers of the thriftiest young trees.

The reserve stands in question occur on approximately 39,000 acres of cut-over land, situated in what are locally known as the Solomon Butte and Mt. Scott units. These units are on the eastern slopes of the Cascade Mountains and a few miles distant from the famous Crater National Park.

Description of the Cut-Over Lands

These cut-over lands are largely surrounded by pure stands of lodgepole pine (*Pinus contorta*). Some virgin ponderosa pine timber forms part of the south and west boundary. The topography is characterized by low, rounded buttes and gently sloping ridges. The soil is a deep volcanic pumice with infrequent rock outcrops. The range in altitude above sea level is from 4500 to 5600 feet.

The reserve stand consists principally of the ponderosa pine (*Pinus ponderosa*) in mixture with the sugar pine (*Pinus lambertiana*), white fir (*Abies concolor*), incense cedar (*Libocedrus decurrens*), and

Douglas fir (*Pseudotsuga taxifolia*) on the higher ridges and buttes. The reserve stand is quite uniformly distributed and has an average merchantable volume of approximately 3600 board feet per acre of ponderosa pine alone. The great majority of the ponderosa pines are of the "bull pine" type, with sharp pointed crowns, long dark green needles and rough, dark bark. Practically all the trees fall in Dunning's tree classes 1, 2 and 3.

It would be difficult to find more ideal growing conditions for ponderosa pine in southern or eastern Oregon. In spite of the series of dry years that has prevailed for the past decade, the ground cover consisting of bitter brush (*Pershia tridentata*) at the lower elevations, and snow brush (*Ceanothus velutinus*) and Chinquapin (*Castanopsis chrysophylla minor*) at the higher elevations, is being rapidly overtopped by a dense growth of subsequent ponderosa pine reproduction over much of the area. Seedlings with leaders from eighteen inches to two feet in length are a common sight. The excellent timber growing quality of this land is further attested by the average cut of ponderosa and sugar pine of 17,325 board feet per acre when the mature timber was logged. A ponderosa and sugar pine cut of 15,826,340 board feet, Scribner Decimal C Rule, was made from one 640 acre section.

CHARACTER OF THE INFESTATION

Before 1931 the chances of the beetles ever reaching an epidemic status in such thrifty fast growing timber seemed remote. Indeed, the beetles remained endemic on the area for a number of years prior to 1931 while at the same time they were severely damaging near-by ponderosa pine timber over large portions of the Klamath Reservation and the Klamath Basin.

In April, 1931, a northeast wind of tremendous violence uprooted and broke thousands of trees on the exposed ridges and slopes of the cut-over lands. Most of the uprooted trees still had enough roots attached to the soil to keep them green until late in the summer, but they were in such a crippled, dying condition that they proved to be enticing bait for the pine beetles. This great abundance of slowly dying trees, together with the warm, dry summer and fall of 1931, enabled the beetles to breed up to enormous numbers before cold weather set in. By that time practically every windfall had been attacked.

The top sides of the logs were attacked by the Oregon pine engraver (*Ips oregoni*) and by the pine flat-headed borer (*Melanophila gentilis*) while the under and shaded sides of the logs were attacked by the western pine beetle (*Dendroctonus brevicomis*) and the mountain pine beetle (*Dendroc-*

TABLE 1

AN ANALYSIS OF INSECT LOSSES

(Data taken from infested pines marked for treating on 29,477 acres of cut-over land, Solomon Butte and Mt. Scott areas, Klamath Indian Reservation, Oregon, fall of 1932.)

Species of pine attacked	Cause of death	Number of trees treated	Per cent of total number of trees treated	Average d.b.h. in inches	Board feet volume treated	Per cent of total board foot volume treated	Average No. of trees treated per section
Ponderosa	D. brevicomis	1568	46.0	18.1	624,556	54.8	34
Ponderosa	Ips & flatheads	214	6.3	15.5	54,904	4.8	5
Ponderosa	D. monticolae	1514	44.4	15.5	373,190	32.8	33
Sugar pine	D. monticolae	112	3.3	20.6	86,936	7.6	2
Totals and averages		3408	100 0	16.9	1,139,586	100.0	74

tonus monticolae). While it was apparent that each windfall supported only a light brood of the western or mountain pine beetles, the windfalls themselves were so numerous that in the aggregate they contained a vast horde of the insects.

The unusually heavy precipitation of the winter of 1931-1932 was so favorable for tree growth that it was thought the beetles would make no headway in the standing green trees. However, as the summer advanced, large groups of trees in the vicinity of the previous year's windfalls began to fade and die from beetle attacks. Groups of ten to fifteen thrifty, vigorous trees with breast high diameters ranging from ten to thirty inches, were frequently successfully attacked.

As soon as it became evident that the beetles were making such a successful, aggressive attack on the reserve stand, it was decided to concentrate control efforts on the most valuable of the cut-over lands. Accordingly, during the fall season of 1932, a control project, covering 29,477 acres of cut-over land of the Solomon Butte and Mt. Scott areas and 4730 acres of adjacent badly infested mature timber, was carried out from two strategically located 20-man control camps. A total of 4375 trees were treated by the peel and burn method, at an approximate cost of $5.12 per tree. All of the laborers employed were Klamath Indians.

THE AMOUNT OF THE BEETLE DAMAGE

The species, cause of death and diameter of each infested pine were recorded at the time the trees were marked for treatment. Unfortunately no crown classification of the trees was made. These data appear in summarized form in Table 1. The table shows the average diameters of the insect-killed trees, and the amount of damage caused by the more important insects.

Because of its ability to complete two generations in one year, the western pine beetle caused a much greater amount of damage than the table indicates. The trees marked for treating in the fall of 1932 represent only part of the 1932 beetle damage since beetle-abandoned trees are not included in the tabulation. It was easily evident in the field that the western pine beetle successfully attacked trees of all diameter and crown classes—from slow growing, suppressed trees to fast growing dominants and co-dominants. Not a single ponderosa pine was found that had successfully repulsed the attacks of these beetles.

The Ips and flathead beetles caused a negligible amount of damage on the Solomon Butte and Mt. Scott area. However, on other cut-over lands of the Klamath Indian Reservation, they have killed almost as much timber as the western pine beetle.

The successful attacks of the mountain pine bettles were largely confined to the smaller, slower-growing suppressed and intermediate ponderosa pine and sugar pine. Hundreds of thrifty trees successfully repelled the attacks of these beetles by copious pitch flows. The sugar pines were attacked exclusively by this insect.

PROBABLE FUTURE TREND OF THE INFESTATION

A large precentage of the beetles were winter-killed in December, 1932 and February, 1933, during two extremely cold periods of several days' duration, characterized by minimum temperatures ranging from 20 to 30 degrees F., below zero. An analysis of thirty-seven samples of bark of varying thicknesses, by the Forest Insect Field Station, Bureau of Entomology, U. S. Department of Agriculture, at Portland, Oregon, showed that 89.6 per cent of the average western pine beetle larvae had been winter-killed. This remarkable and unusual winter-killings may bring this epidemic to an end. If moisture conditions favorable for increased tree vitality continue and no additional windfall takes

place, it is reasonable to assume that there will be a cessation of insect losses on these areas for some time.

CONCLUSIONS AND RECOMMENDATIONS

It is apparent that the aggressive nature of the western pine beetle has not been fully appreciated. When climatic factors are favorable, and when a large amount of fresh windfall is on the ground, they are able to rapidly increase in numbers and can successfully attack and kill thrifty, fast growing ponderosa pines above ten inches in diameter. It is also clear that recommendations to timber-markers, regarding the classes of trees to leave, are difficult to make in face of the fact that the western pine beetle will successfully attack all crown classes and all diameter classes above ten inches.

When marking trees for logging in a badly infested body of timber, the writer believes that most of the "bull pines" of merchantable size should be taken, unless provisions are made for such control work as may prove necessary after logging operations. No changes seem desirable in the present marking practice when marking lightly infested timber.

Foresters should understand the conditions that are favorable for bark beetle development and should learn to recognize incipient infestations. Warm, dry summer seasons and mild winters are ideal for the rapid building up of infestations. Under such conditions, a bad windthrow is sure to be followed by beetle trouble.

The writer's experience leads him to believe that the following measures will help to prevent the buiding up of an epidemic infestation when a bad windthrow occurs:

1. Buck up each windthrown tree close to the root-collar. This will stop the flow of sap from the roots which are still functioning, and will greatly shorten the length of time that the trees are desirable breeding places for tree-killing insects.

2. Lop off the branches of the windthrown trees. This procedure will expose much of the bark to the direct rays of the sun and will discourage attacks in such bark by the western pine beetle and mountain pine beetle.

Harold Weaver,
U. S. Indian Service.

REVIEWS

The People's Forests. By Robert Marshall. *Harrison Smith and Robert Haas, New York. 231 pages. On sale by the Society of American Foresters, Washington, D. C. $2.00.*

It is not customary for the Editor to write the reviews in the JOURNAL OF FORESTRY. It would seem particularly out of order in this case because his political and social concepts are so diametrically at variance with those of the author that what he writes must inevitably reek with adverse criticism. The task is undertaken solely on the urgent request of the author himself, who is anxious to have his theories and proposals exhaustively tested. If all of us forestry doctrinaries were equally able to accept professional differences of opnions as such, and could keep them free from personal antagonisms, surely our progress toward the commonly desired goal would be far more rapid than it has been.

The common goal of all students of our forest problem, presumably, is some workable and working system of nation-wide forest conservation under which all forests of the country will be soundly managed and their resources perpetuated to the extent that the public good requires. More than one scheme to attain this end has been advanced. Now comes Robert Marshall with his scheme. He is sincere in his belief that he has the right answer. We therefore should consider and weigh his proposals with equal sincerity. Let us see what he offers.

He re-paints, with the hand of an artist, the oft exhibited picture of progressive forest devastation. He reiterates in graphic style its concommitant evils. He re-emphasizes the pressing need, to avert national disaster, of doing something about it, and doing it right now. He gives short shrift to private ownership or private initiative in truly communistic fashion. He sees no possibilities in coöperative regulation toward which the conferences on Article X of the Lumber Code are pointing. He sees hope only in direct and wholesale public ownership. He looks beyond mere government ownership of the land, as typified by the present national forest system, and envisions also government ownership and management of the logging operations.

In outlining a method for transferring to public title the vast acreage involved, he passes up confiscation, or expropriation, solely on the grounds of its present inexpediency. Only because the capitalistic benightedness of our people is still so strong that they will insist on their constitutional rights, he proposes an alternative of acquisition by purchase. In this he recognizes the enormous cost, and he justifies it by weighing against it the far greater benefits which he alleges will accrue. He reasons with the assumed suavity of one of these wicked bankers, floating a South American bond issue. His explanation that the investment will prove self-supporting and as the years go on will return to the nation a steadily increasing profit, reads like the prospectus of a professional promoter, generous with the spending of other people's money. These passages of the book are exceptionally well done and read most intriguingly. "Caveat emptor!"

Marshall's sketch is more like a water color of New York's skyline by an impressionistic artist than the blue prints of the engineer who must plan and erect the build-

ings which make the skyline. If it will aid the forest engineer to plan and build rightly it will be to that extent useful—but the vision must be practical. Is it? His forest recreation vision the reviewer himself is strongly tempted by his sentiment to support. His own love of the woods and the wild places, and all the good things that go with them, leads him to lend a more than sympathetic ear to any plan that would preserve them from uglification by our mechanized civilization and from desecration by an unappreciative hoi polloi. When, however, the plan to accomplish that purpose involves the lavish spending of other people's money, he cannot help but feel that sentiment must not be allowed to become sentimentality but must be ruled somewhat by common sense; that we should first make sure that the people, whose money it really is, want it spent in that way. For us to decide that they ought to want it is not enough.

For supporting evidence in his brief, Marshall draws freely on the "Copeland Report." That monumental and invaluable compilation of forest facts, interlarded with instructive and constructive foresters opinions, has been characterized as our forest bible. Those of us who have some slight knowledge of religious history will remember that for many generations the favorite indoor sport of the theological doctrinaire has been to search the pages of the Book of Books for quotations of theory and opinion and alleged fact which would serve as supporting evidence to his preconceived dogma. By that process the soundness of scores of variant, conflicting and sometimes directly opposing religious creeds has been irrefutably proven. It would not be difficult to use the Copeland Report in the same manner with regard to forestry creeds and one wonders if that is not what our author has done. It is known that he was unalterably convinced on the complete socialization of our nation's forest resources long before the Copeland Report was ever conceived. One might be pardoned, therefore, for suspecting that he has been writing more with the mind of a lawyer preparing his brief, than of a scientist searching for the truth. The lawyer of course seizes and enlarges upon that evidence which will strengthen his side of the case and slurs over or belittles such as would weaken it. The scientist, on the other hand, approaches his problem with no preconceived opinions, but with an absolutely open mind; he assembles, digests and analyzes all available facts and arguments bearing on the question in any way whatsoever, and attempts to deduce therefrom the correct answer.

There are, both in the Copeland Report and in other sources of information on the forest situation, data and lines of reasoning pointing to other conclusions than those reached by Marshall. It would be unfair to charge him with having failed to consider them. It would be equally unfair not to apprise the reader that such evidence exists, so that when he sits down with "The People's Forests" he may know that he is reading not a complete and thorough analysis of our so-called forest problem, but rather a most engagingly prepared brief in support of one out of several possible solutions of it.

One who is at all experienced in the making of investments knows that the honesty and competency of the management is fully as essential to the success of a business enterprise as is the soundness of the idea and of the plan of operation. Competency is probably more important than honesty. Even in this cynical age there are plenty of men whose intentions are good but whose ideas are impractical and who are lacking in executive ability. Such men, as managers, are as likely to wreck an otherwise sound undertaking as the dishonest crook.

A weakness of our democratic form of government, and to a less extent of our capitalistic system, is that neither of them

provide a scheme or method for always putting and keeping the right man at the top,—for always maintaining a personnel in charge which is both honest and competent. Those who would substitute for our present arrangements some socialistic or communistic system, under which business and government are combined, have likewise failed to solve this important personnel problem. They seem to labor under the delusion that their pet plan will automatically attract to it all, and only, the best and noblest in human nature and will of itself develop directors and managers of the required integrity and ability. They do not seem to realize that the self-seeking "cause rider" will be just as ready to climb onto their chariot as on any other.

The framers of our American Constitution were much wiser than this in their understanding of their fellow man and his weaknesses. They knew full well that no form of government and no scheme for choosing its leaders would insure always putting and keeping the right man at the top. They foresaw clearly that, even under a system of popular election, far more often than not men would come into high office who could not be entrusted with too much discretionary authority. They devised accordingly a form of government that was negative rather than positive in character, whose primary function would be to prevent injustice to its citizens, and they hemmed the ruler around with restrictions to prevent him from abusing the power of his position.

Marshall, in his plan for the complete socialization of the nation's forests and forest industries, and in his effort to sell it to the prospective investor, the public, assures us that it will be efficiently executed by competent and honest managers. Shall we take his assurance on faith?

Beyond this point in the review it is difficult to go without becoming enmeshed in a fruitless discussion of the merits of a socialistic form of government. The author of the book is frankly and firmly committed to such. The writer of the review is similarly firm in his faith in the American ideal of government. The former would socialize, not only the forest resource, but all natural resources and all basic industry. He would go the whole hog: he would regimentate the whole works, and leave to the private citizen the least possible freedom of initiative, for fear that in his selfishness he might abuse that privilege: he would have the whole country organized and run right,—by whom? The latter still believes that that form of government is best which guarantees to its citizens the widest possible freedom of initiative and action in the conduct of their business and their private life, which functions primarily as an umpire to insure fair play, and which reaches over into the field of management only in those exceptional instances where private enterprise plainly cannot serve the public need. He would even question if government has not already, in some particulars, reached over too far into the field of management and should retrench rather than expand. He recognizes, of course, that the game of life is constantly changing, is continually growing more complicated, and that the rules of fair play to govern it must be frequently and repeatedly modified and amplified to keep pace. He believes in evolution, not revolution, in our form of government. In the economic mess in which we are now wallowing he sees at work the evolutionary process of bringing up-to-date our rules of fair play which we in our carelessness had allowed to become too antiquated. With all this he believes firmly in the possibility of so modernizing our rules of forest practice (including a limited expansion of public ownership) as to safeguard adequately the public interests at stake and at the same time preserve the invaluable features of private initiative and enterprise.

Admittedly, such views are not in style this season. It is no longer the vogue to laud "rugged individualism"—that went out with the Hoover administration. It is much more in fashion to belittle private enterprise, to sneer at its faults, and to deny that it possesses any virtues whatsoever. Undoubtedly, therefore, the author of "The People's Forests" is nearer in keeping with the current mode in political and economic thought than is its reviewer, who, for his own social and professional good, would perhaps be wiser to keep his mouth shut and his pen in his pocket.

Since, however, this review must be written, it would seem that there is nothing left for the reviewer but to give way to his natural reaction and say, "This 'People's Forests' is indeed a dangerous book. It is so attractively gotten up, so pleasingly written, and pleads its cause so plausibly that the superficially informed layman who peruses it is too certain to be artfully seduced to the support of a pernicious and subversive doctrine." He might consistently go one step further, and urge that the book be suppressed, all copies destroyed forthwith, and the author forever enjoined from further utterance of his theories. But what a stand that would be for a self-announced staunch and uncompromising supporter of American ideals of government, which safeguards to its citizens their inalienable right to speak their minds freely. His consistency would become most inconsistent.

Therefore, if Marshall's doctrines are pernicious, if his premises are unsound, if his reasonings are illogical, his audience should be competent to decide for itself, and should be urged to do so. Its thinking should not be done for it by an egocentric, self-opinionated writer of reviews who lives perhaps too much in the past and whose stiffened knees and ossifying brain will not permit him to keep abreast of the progress in modern thought.

The gentle reader must decide for himself if the author is justified in reviving the discredited bogey of an impending timber famine and parading it again in a new clean sheet to the horrification of the little children, if he is right in disregarding the modern statistical knowledge concerning trends in timber and wood consumption in relation to supply, both present and prospective. The dear public must itself determine if the preservation of forest recreation values on a national scale are so essential to its well being that it can and will dig deep into its pocket for the purchase and maintenance for that purpose exclusively of scores of millions of acres, and dig deeper still to buy other and vaster acreages where timber crops may be grown under the practice of forestry and the demands of sordid commercialism gratified, that it may not encroach upon the unsullied virginity of the "superlative," the "wilderness," and the other areas to be devoted solely to aesthetic enjoyment and to pleasure.

If the reading public is too dear and gentle, after reading the book, to reach its own sound conclusions in such matters, then it is certain indeed that our race is not possessed of that idividualistic ruggedness of character, and capacity for private initiative that would entitle it to a government of the people, for the people and by the people. "The People's Forests" will indeed have served a useful purpose in proving the need of a goverment by an aristocracy of intelligentsia, which must perforce be self-appointed, because there will be no brains elsewhere competent to do the picking.

Franklin Reed.

Job-Load Analysis and Planning of Executive Work in National Forest Administration. By E. W. Loveridge. *Published by the Forest Service, U. S. D. A., Washington, D. C. Pp. 236, 1932. For sale at $.25 by the Supt. of Documents, Washington, D. C.*

At a period like this when current misconceptions of the work of the federal Civil Service may do great harm to the progress of its more substantial units, this study of the methods by which true economy may be achieved is particularly timely. It is in line with the conviction and hope of friends of the Civil Service that our federal agencies, under proper administration, could well be leaders in the movement for scientific management.

While this report applies itself to a specialized problem in a rather particularized type of work, its broad approach identifies it with the world technique which has as its basis a scientific search for the newer and better way, as compared with the traditional method. It attacks management at the molecule of the individual job-load and replaces guesswork or superficial opinion by painstaking analysis. Above all its detailed reference the report has the virtue of a fresh appraisal of method and is a definite enemy of the tendency to stay in the deep grooves formed by habit and self-complacency.

In attacking with courage the complicated problem of the work of individual foresters through the method of job analysis, the report lays the basis for a wide variety of improvements in general administration, viz., the method of work, the persons who should be selected to do it, the equalization of job-load assignments, the establishment of a better salary basis, the more effective use of appropriated funds, and other objectives of good management. In emphasizing the importance of keeping such job-load analysis up to date, the report has the further advantage of pointing out the importance of not relaxing in one's scientific attitude if the work of the Service is to be kept abreast of the best administrative practices and in line with changing conditions.

With regard to the actual breakdown in the samples of job analysis presented, and many other technical matters, one who is not a forester is not in a position to criticise, though he may be very much impressed by its thorough character. One can readily see, however, that in its application of principle to a new field the report is an important addition to the practical literature of scientific management, and if it is a first published effort of the Forest Service, it is a notable one. The suggestion that it is a first effort arises from the perhaps over-frequent citation of authority and excessive use of quotations. The author has shown his capacity to do at least as good a thing as many of the authorities cited, hence in future, as an established and authoritative convert to the creed of scientific management and enlightened personnel technique, he may well speak in his own terms so that we may quote him.

HERMAN FELDMAN,
Amos Tuck School of Administration and Finance.

First Annual Report of the National Land Use Planning Committee. *Publication No. 5 (mimeographed), Washington, D. C., July, 1933, Pages 19.*

The National Land Use Planning Committee organized as a result of the National Conference on Land Utilization held in Chicago in November, 1931 pre-

sents a resumé of its activities to June 30, 1933 in this brief mimeographed report. This committee is composed of sixteen members, eleven of whom are employees of the federal government and the other five educators.

The committee has considered in the eight 2 to 3 day sessions and in the six mimeographed and one printed publication thus far issued, not only many of the broad gauge, long-time problems in the field of land utilization, but also some of the current problems as reflected by proposed federal legislation.

In its publication No. 6—"The Problems of 'Submarginal' Areas, and Desirable Adjustments with Particular Reference to Public Acquisition of Land," it outlines the major problems found in areas submarginal for agriculture and recommends the principles upon which a public acquisition program might best proceed.

The committee courageously attacks the old problem of public domain grazing in its publication No. 4—"Conservation of the Grazing Resources of the Remaining Public Domain." It approved the principles embodied in the Colton Bill, but not the amendments thereto.

Other meetings and publications (No. 3 and No. 7) were devoted to the question of underground water resources and land use planning in the Tennessee River Basin. The committee pointed out that adequate regulation of underground waters is essential to wise land planning and in publication No. 3 discusses the principles that should prevail and presents there an abstract of underground water laws.

Other timely subjects considered by the committee since its organization include (1) the refinancing of distressed irrigation, drainage, and other reclamation districts of which in one state 37 districts out of 95 were in default; (2) the "back to the land movement;" (3) federal-state relationships in taxation; (4) forests, parks, recreation and wild-life preservations; (5) relation of urban and rural planning, and so on.

The efforts of this committee and its companion committee, the Advisory and Legislative Committee, have been productive of much that is socially desirable and worthwhile. It is unfortunate that its publications, except for one report, have been presented to the public via the less effective and ephemeral mimeographed route. It is to be hoped that the committee will not only continue its critical analysis and clear forwarding looking recommendations on basic and on current problems, but that these will be more widely disseminated and in more permanent form.

P. A. Herbert,
Michigan State College.

Analysis of Logging Costs and Operating Methods in the Douglas Fir Region, by Axel J. F. Brandstrom, *Pacific Northwest Forest Experiment Station, 1933, pp. 117, figs. 47, tables 54.*

This bulletin, by a recognized authority in the field of logging engineering and forest management, thoroughly analyzes existing operating methods and treats of the basic changes needed in logging to better handle the forest investment. The report appraises the relative merits of the logging equipment commonly used in the region from the crawler tractors and small size yarders to the large swing units and 100-ton tower skidders.

Preliminary studies by the writer as long ago as 1920 indicated serious deficiencies in conventional logging methods, the trend being toward high-speed, mass production methods which for the sake of meagre operating economies unwittingly sacrificed potential and existing revenue.

In further connection with this problem, the writer in a field study by the Pacific Northwest Forest Experiment Station during 1931 and 1932 made stop watch studies to cover the wide range of log extraction, loading and rail-roading methods and physical conditions found in the region. Altogether about 35 million feet of logs were timed from stump to track and, in addition, numerous operating cost records furnished by coöperating companies were examined. These analyses furnish the factual information in the report.

Following a foreword by Col. W. B. Greeley, an introductory chapter summarizes the growth and development of lumbering in the Douglas fir region. The seventeen succeeding chapters give detailed descriptions of the principal time studies, log extraction and loading methods. One chapter is devoted to skyline swinging, another to yarding, another to tractor roading, and so on until all of the major yarding and loading methods in use have been described, analyzed and discussed. This part of the report cannot be recommended to the casual reader. Though the numerous tables and figures have been simplified and condensed as much as possible, they are nevertheless heavy reading to those uninterested in the technical qualities of logging equipment.

From his analysis of the factual information the writer draws the conclusion that excellent opportunities exist for cost reduction through adaptation of logging machinery to specialized work and through intensive selection of logging settings. The range of tree size and topography on a Douglas fir logging operation is so great, as Mr. Brandstrom points out, that to divide the area into a few large logging settings makes the process of log assembly at the landing inefficient and invites the removal of trees which show a deficit for their handling. The combination of specialized yarding equipment and intensive selection of settings or selective-specialization, as the writer terms it, leads to group or individual tree selection, lighter machinery, smaller settings, flexibility in yarding and skeletonizing of the railroad system.

The keynote of selective specialization is flexibility in yarding and the writer shows how this can be accomplished. He states in Chapter XIX that, "the greatest opportunities toward efficient, low-cost logging enter through the use of the crawler tractor, either for direct yarding or for roading with or without previously prepared roads, in combination—where uphill, rough country or wet weather logging is encountered—with the small sledded or tractor-mounted highlead yarder or the conventional skyline swing system.

"In using these methods or combination of methods, the operation should be planned primarily for tractor logging with the more expensive methods figured in only where unavoidable, and with reliance on railroad spurs reduced to the minimum compatible with continuous and effective transportation."

The last chapter of the bulletin outlines the logging program to be followed in opening up and developing a hypothetical timber tract. The logging plan aims (1) to obtain year-round production from the tractor operation and yet confine the actual roading to the dry weather; (2) to decentralize the stump-to-rail operations and to keep them independent of the loading; (3) to standardize the roading, loading, and rail-road hauling; and (4) to obtain complete selective control of the timber property.

It was fortunate for the success of this study that one of the coöperating companies before publication of the report, carried into effect the principles outlined in the chapters on selective specialization. Instead of being abstract conceptions, the principles are strongly backed by the fact-finding evidence of a representative case study. The coöperating company found that by using tractors and through better

planning there occurred: (1) a reduction in cost amounting to about 40 per cent of corresponding donkey costs for distances involved in the experiment; (2) a reduction in breakage, the saving in this particular case being sufficient to pay for the entire cost of roading and road construction; (3) a high degree of selectivity which may be applied to obtain important economies in loading and railroading.

The bulletin contains about 75,000 words in addition to numerous tables, figures and illustrations. The effect of length which the report may have on the reader is primarily due to the technical details in the first half of the report and the wealth of ideas new to Douglas fir logging in the last half.

Throughout the bulletin, Mr. Brandstrom carries the thought that good engineering and good economic practice are also good forestry. He aims to handle the forest investment in the best possible manner during the process of logging, and it appears that the resulting silviculture is often as good as when silviculture is practiced as an end in itself.

The bulletin opens up a large field for the lumber industry and shows unmistakable possibilities for larger profits and better conservation of the forest resources. As Colonel Greeley says in his foreword, "It (the bulletin) will help the logger in solving his master problem—how can this tract of timber be operated for the greatest cash return? It lays the ground work for practical and promising developments in selective logging—a vital factor both in liquidating present investments and in keeping our forests productive. I heartily commend it to the industry for study and use."

This study by the U. S. Forest Service was coöperated in by the West Coast Lumbermen's Association and by the Charles Lathrop Pack Forestry Foundation, the latter sponsoring publication of the report. A second bulletin dealing with the financial aspects of timberland management is in preparation under the joint authorship of Mr. Burt P. Kirkland, also of the Forest Service, and Mr. Brandstrom.

E. F. Rapraeger,
Pacific Northwest Forest Experiment Station.

Air Survey in the Service of Forest Management with Recommendations for its Further Development Particularly in Undeveloped Countries. M. R. Jacobs. (English Summary).

This dissertation, which was accepted by the Tharandt Forest School for the Degree of Doktor-Ingenieur der Forstwissenschaften, deals with the service rendered to forestry by modern developments in air-survey.

Air-survey has been and must continue to be of enormous importance to new countries, where the low average unit value of land prohibits the use of many intensive survey-methods that are common practice in Europe. By exploiting the bird's-eye view and the transport facilities now offered by the aeroplane, natural scientists in various new countries have, during the last 15 years, carried out topographical, botanical and soil reconnaissance work that would have been economically impossible before the aeroplane was developed. During the same period there have been developed in Germany very accurate instruments for the taking and interpreting of aerial photographs. This development culminated in the production of Hugershoff's Aerocartograph and similar machines, by the aid of which accurate contour-maps may be made from stereoscopic aerial photographs. So accurately may heights be determined in the Aero-cartograph (about ± 50 cm with photos of a scale of 1:10000) that

even the heights of trees may be measured. This fact offers new possibilities to forest management, as it gives the opportunity of measuring tree heights and thus the volume of timber stands from the same photographs used in topographical or ecological surveys.

In the thesis it is shown how air-survey in new countries may benefit from the intensive methods evolved in Germany. At the same time it gives an account of the writer's experiments in forest survey and assessment work with the aid of the aerocartograph and other instruments.

The thesis contains a concise but fairly complete summary of the more important air-surveys of interest to foresters. These may be divided into three kinds. Firstly, the bird's-eye view may be exploited by sketching directly on to a base-map. This method is purely qualitative, but gives very useful results and is of great value as a preliminary measure to a more intensive survey. Secondly, it is possible to map by oblique aerial photographs. This method is of value for reconnaissance work in areas where no base-maps are available, or for final work where land values do not permit of more intensive methods. Finally, it is possible to map from vertical aerial photographs, which give a more or less central projection of the land beneath. From these vertical photographs maps may be made in three ways. Firstly, the original prints may be used as a map; however this method does not do away with the errors caused by tilt, etc., of the aeroplane. Secondly, it is possible by means of a rectifier, to make the negatives an accurate central projection of the area photographed. Even this method leaves errors due to the relief of the land. Diagram 1 on page 39 gives an idea of the errors caused by this method. Uneven land can only be accurately mapped by the use of steroscopic photographs and an instrument such as the aerocartograph. This is the third and only accurate method of topographical survey from the air. In official trials the aerocartograph exceeded the accuracy required by the Swiss Survey Department (a lateral accuracy of 0.3 mm on the plan and an accuracy in the determination of the elevation of points from the contours of 1.2 m for a map of 1:5000).

After dealing with the organization of air-surveys in undeveloped countries (p. 31-52) the thesis deals with the measurement of forest stands from vertical aerial photographs. The method of obtaining the breast-high-diameter (d) from the crown-diameter (k) by means of the relation k:d is discussed. A simple method of measuring k from the aerial photographs by means of a wedge scratched on cinema film was evolved (p. 54), also a practical way of measuring k during control operations in the forest (p. 53). The density of the stand was calculated both from the Aerocartograph and from single prints by means of fine parallel lines scratched close together on cinema film. In the opinion of the author there are great possibilities in methods of measuring forest stands by height and density alone. The reasons for this conclusion—based on a careful examination of European yield tables—are given on p. 56.

By means of a sample survey carried out with the help of aerial photographs in the Weisser Hirsch Forest near Dresden, some of the possibilities of forest survey with the help of such instruments as Hugershoff's Aerocartograph are demonstrated. Here an accurate contour map was made of the area in the aerocartograph, and for the estimation of the average heights of the various woods an actual strip assessment was carried out in the laboratory, a thing for which the aerocartograph is especially suitable. The details of this work are given on pages 58-66. These details include a complete tabular description of a section of the forests, for which all the information was obtained with the help of the aerocartograph and the Zeiss Airman's Stereoscope.

At the conclusion of the thesis a list of the literature on the subject is given.

Dr. Franz Heske,
Tharandt Forest School.

Forsok med vestamerikanske traeslag. (German Resumé.) Experiments with western North American trees. By Oscar Hagem. *Publication No. 12, Vestland Forest Experiment Station. Bergen, 1931.*

In this publication the author discusses the results of experimental planting in the western part of Norway of various species which are native to northwestern North America. Among the species used were *Picea sitchensis, Tsuga heterophylla, Thuja plicata, Pseudotsuga taxifolia, Chamaecyparis nootkatensis, Abies amabilis, Abies grandis, Abies lasiocarpa,* and *Abies nobilis.*

The experiment was based on the principle of naturalization, rather than of acclimatization. "Naturalization" infers that climatic conditions between area to be planted and the original home of the species are identical. The most important of these factors is temperature. Hagem believes that temperature is the most vital factor affecting the northern limit of the range of a species. This holds true whether one considers the northern limit of distribution as a limit of plant growth or of seed production, that is, seed being produced in such small quantities as to be unable to form a stand. In the further subdivision of the temperature the author states that the average temperature of the growing season for alpine and polar species is a vital factor.

In Norway, Helland (1912) showed that the alpine and polar limit of Pinus sylvestris and Picea excelsa (excepting the West Coast) is at a summer temperature of 8.4°C. This is figured as the mean of the averages for the four months, June to September inclusive. Later investigations by Hagem (1917) substantiated these results, who also found that to get a proper ripening of seed of Pinus sylvestris, a mean temperature of 10.5°C. was necessary. For Picea excelsa it was about 10.0°C. Eide (1930) on the basis of more data arrived at a value of 9.5°C. for this species.

Besides using the mean of the average temperatures the four summer months, Hagem used four other factors in determining whether two areas were similar enough climatically to introduce exotics. These were the length of the vegetative period over 7.5°C., winter temperatures, precipitation, and the character of the climate.

Frost, for instance, is likely to cause heavy losses, especially of the young trees. Probably the acid test of an introduced species is its survival in the seed bed where frost damage is often very high. Hagem in dealing with frosts divide them into three classes, i. e., fall, winter, and spring. Theoretically, the early frosts which occur in the fall tend to freeze the cell materials before the plant has properly hardened and ripened. Late frosts in the spring cause damage by destroying tissue which has already begun active vegetative growth. Damage by low temperatures during the actual winter months is not usually serious to native species, except in the case of abnormally low temperatures. More serious damage, however, is incurred by trees whose origin is the farther south provinces.

In introducing any exotic species to another country Hagem emphasizes the importance of planting the introduced species where it will have its climatic optimum. By the term "climatic optimum" he implies an area having the same climatic conditions as those which the parent tree grew under.

In comparing Norway with northwestern North America it is found that a 1350 kilometer belt along the coast of British Columbia and Alaska between Cape Flattery and Mt. Fairweather has essentially the same type of climate as the coast of West Norway between Farsund and Lödin-

gen. Hagem gives a detailed climatic comparison between the smaller subdivisions of West Norway and British Columbia and Alaska but this will be omitted here.

SUMMARY OF RESULTS OF PLANTING BY SPECIES

1. Sitka spruce. (*Picea sitchensis*). Forty-nine seed samples were tried whose origin ranged from the state of Washington to Alaska. The best source was found to be the outer coats and fiords of Alaska at 57° to 58° north latitude. These were able to withstand the most severe winters of Softeland in Norway with practically no loss.

2. Western hemlock (*Tsuga heterophylla*). Sixteen sources were tried of this species, one being from Alaska, two from the United States, and the rest from British Columbia. This species behaved similar to Sitka spruce, that is, trees of Washington and southern British Columbia were very sensitive to frost. One fairly good strain was found at Prince Rupert, but the best was found to come from the southern part of Alaska.

3. Western red cedar. (*Thuya plicata*). Fifteen samples were used but the results were somewhat discouraging, considerable damage resulting from sunscald and frost during the second and third years. One source (Alta Lake in southern B. C. 100 kilometers eastward of Vancouver and 670 meters above sea level) proved very hardy but was tested on such a small scale as to need more investigation.

4. Douglas fir. (*Pseudotsuga taxifolia*). Twenty-four samples were used, all of them limited to the coast or fog belt variety. The only thing which showed any real promise was some seed from the Mt. Ida Forest near Salmon Arm. Only 5 per cent mortality resulted at the end of the first year as compared with 20 to 100 per cent for other strains. One sample from the Fraser River area was quite hardy but due to its slow growth it was not of especial interest since the native conifers would have preference over it.

5. Alaskan cedar (*Chamaecyparis nootkatensis*). Only three samples were used and considerable difficulty was encountered with poor and delayed germination. Seed from Chicagoff Island (Alaska) proved the best of the lot.

6. Silver fir (*Abies amabilis*). One lot of seed from the Columbia National Forest in Washington proved the best. Seed collected from an altitude of 950 to 1000 meters above sea level is fairly satisfactory if conditions are not abnormally severe. Seed from higher altitudes was more frost hardy but gave very poor germination.

7. Lowland white fir (*Abies grandis*). No satisfactory results were obtained from any of the lots of seed tried.

8. Alpine fir (*Abies lasiocarpa*). Of the seed tried none seemed to be of any particular value for West Norway. Possibly seed from the higher valleys deserves several more trials.

9. Noble fir (*Abies nobilis*). One lot of seed from Race Track, Columbia National Forest, was quite hardy. This came from an elevation of 950 meters above sea level. Most of the others suffered heavy losses.

J. H. STOECKELER,
Lake States Forest Experiment Station.

Some Factors Underlying Forest Fire Insurance in Massachusetts. By C. C. Averill and L. M. Frost. *Harvard Forest Bulletin No. 17, Petersham, Mass. 1933.*

Following a condensed history of forest fire insurance in Europe and this country, the authors explain why so little practical progress has been made in this activity in America giving, as the chief reasons; past inadequate forest protection, the publicity given to large forest fires, and the lack of definite loss

data together with slight knowledge of comparative risks. They p articularly emphasize the need for "an intelligent and properly formed public sentiment" regarding forest values.

On the premise that an increased intensiveness of forest management on private property will bring an increased desire for forest insurance to reduce the financial risk of growing commercial timber, the study proceeds with an analysis of fire loss conditions in Massachusetts during the five to fifteen year period prior to 1930 in order to disclose the true facts underlying the possibility of forest fire underwriting and the probably essential future developments.

Using such existing data as are reliable the authors have analyzed fire occurrence and the extent of damage statewide, and show that there are distinct zones of fire hazard which correlate definitely with such identifiable factors as density of population, location of main routes of travel, and general soil conditions. They conclude that there is no significant climatic variation in the state.

For intensive analysis, to identify and measure factors of relative hazard, of which existing fire records give no indication, the authors selected a number of extensive forest properties aggregating approximately 8,000 acres, the fire histories of which were definitely known for a fifteen year period. These properties are all in what the authors designated as the general zone of medium hazard (west central Massachusetts). Recognizing three major factors of hazard—combustibility; exposure (to causes of fire); and protection (having negative effect)—they develop, through field analysis and interpretation, a schedule for grading properties according to simple and practical factors of variable hazard, together with means of expressing various grades in terms of insurance rates.

The authors were greatly handicapped by a shortage of basic data needed for such a study and lack of time to build a broad statistical base for themselves. Their ingenuity in solving the problem thus faced, and presenting authoritative material convincingly expressed, is highly commendable.

The wide range of forest fire hazard is so far only partially comprehended, either as to its extent or the factors involved. The authors bring these facts out clearly and show plainly that, in spite of the great need for improved forest fire conditions, there is nevertheless even now a large aggregate of forest property that is insurable at rates which compare very favorably with the best forms of other property.

They make clear the requirement that, if practical forest fire insurance is to come into being, there must be reasonable assurance that adequate protection will be maintained, that ready means must be available for the grading of all properties, that accurate knowledge must be had of the distinction between insurable and uninsurable properties, and that the project must be supported by the owners of a large and well distributed aggregate value.

H. B. SHEPARD,
Pacific Northwest Forest Experiment Station.

Poda dos Sobreiros (Pruning of Cork Oaks). By J. Viera Natividade, *Direction General, Service of Forestry and Agriculture, Bulletin of the Ministry of Agriculture, 13th year, No. 2, First Series, Lisbon, Portugal, 1932. Twenty-nine pages, thirty-two illustrations and figures, summary in French.*

In recent years a system of management of cork oak stands has grown up in Central Portugal and adjacent portions of Spain which bears close analogy to a system of orcharding, with the impor-

tant exception that the trees are natural growth forest trees and the production of fruit is only one of the objects of management.

This system, resulting from an interesting marriage of silviculture and horticulture has, so far as the reviewer knows, never been described in either forestry or horticultural literature. Nor, for that matter, does Senhor Natividade describe it at length. Writing as he is, largely for the benefit of cork-growers and landowners in his own country who are familiar with the system, he is chiefly concerned with a discussion of its abuses and in stating methods for its correct application.

It may be therefore worth while to describe the system briefly before discussing the bulletin itself. Originally the cork stands were of greater density and probably composed of somewhat smaller trees than at present and had a very high and dense understory of brush. This brush constituted an exceedingly high fire hazard, and rendered stripping and extraction of the cork difficult. It was gradually removed and the stands thinned. With the thinning and brush removal the grazing became important and with it the acorns, which serve as excellent hog-fattening material. The acorn crop is almost as valuable as the cork itself. Later, it became common practise to plow beneath the now widely spaced trees and plant field crops, and to prune the trees into what the owners believe more desirable form for cork and acorn production, and to permit more light to reach the crops under the trees. A few years ago the greatly increased demand for virgin cork and charcoal greatly stimulated these prunings, and it is not too much to say that they frequently became reckless in intensity. The object of the owner seemed to be to obtain as much virgin cork and charcoal as possible without actually destroying the trees. However, it is only fair to say that the practise in certain Spanish districts is even more radical than in the Portuguese.

Senhor Natividade regards this orchard system as fundamentally a sound one, although he questions the wisdom of sacrificing too much of the crown surface of the trees to encourage crops on typical cork oak soils, which are too poor to produce valuable field crops. Furthermore he regards present pruning practises as so radical as to be prejudicial both to the trees and to the forest. No forester who has seen them is likely to disagree with him. At the Portuguese Forest Experiment Station he has instituted a series of experiments to determine the correct system for pruning cork trees. These experiments have not been in operation long enough to yield conclusive results. Most of the present bulletin is a condemnation of obviously bad practises and a discussion of rational systems of tree pruning as developed by horticulturalists. In the last he has drawn largely on American literature.

The author condemns the removal of large branches, the leaving of stubbs and other common forms of tree butchery, as well as summer pruning, which has an adverse effect upon acorn production. (This last is now forbidden by law. This law also tends to reduce pruning in general since virgin stripped from the pruned branches during the dormant season is less valuable commercially). He recommends removal of inner and smaller branches to obtain a balanced fruit tree form, to stimulate acorn production and to produce a tree easier to strip of cork.

Since nothing of scientific importance is known as to the effect of rational pruning on cork production, Senhor Natividade's experiments should be of great value eventually to the cork industry and of much scientific interest as to the effect of pruning on the bark growth of trees

in general. Meanwhile it is to be hoped that his compatriots and their Spanish cousins will heed the advice in this bulletin and be less energetic in the use of pruning tools.

P. L. BUTTRICK,
Torrington, Conn.

Enquête Internationale sur Les Incendies de Forêts (An International Inquiry on Forest Fires). *Institute International D'Agriculture. 457 pp. Rome, 1933.*

This volume was published in response to a resolution passed by the First International Congress of Sylviculture, held at the International Institute of Agriculture, in Rome. It contains much information on the causes of forest fires in the different countries; on the different kinds of fires and the damage which they do, so that the organization, the principal legislation and the methods adopted for their prevention may be discussed.

The greater part of the information was obtained through the coöperation of competent authorities and individuals in the different countries who have furnished the necessary data to the Institute in response to a world wide questionnaire. Those interested will realize, therefore, that his monograph offers them original documentary evidence on forest fires which it would be very difficult for them to obtain elsewhere.

E. G. CHEYNEY,
University of Minnesota.

SOCIETY AFFAIRS

Doings of the Executive Secretary November 11 to December 10.

On the afternoon of November 10, I attended a meeting of the Executive, or Steering Committee of the Conference on Article X of the Lumber Code. The purpose of the meeting was to prepare a compromise statement reconciling the differences between the Forest Service and the industry proposals to Conference Committee No. 1, on Forest Practice. The morning of November 11 was given over to follow-up on the previous day's committee meeting.

On the afternoon of November 13 attended a meeting of the Interim Committee on Forest Credits of the Article X Conference. Served as committee secretary. Others present were Wilson Compton, presiding, Ward Shepard, Verne Rhoades, B. P. Kirkland, and G. H. Collingwood.

The rest of the month was absorbed in handling a vast amount of administrative routine and in work on the Journal. Since our fiscal year ends on November 30, the books for the year had to be closed, the Society's accounts given their annual official audit, and financial plans for the coming year outlined. Preparations had to be made for the biennial election of President and Council members on December 15, and much time spent on plans for the annual meeting on December 28-30.

On the evening of December 6, the Executive Secretary attended the informal reception to Mr. F. A. Silcox, new Chief of the U. S. Forest Service, at the home of Ovid Butler, Secretary of the American Forestry Association.

Franklin Reed.
Executive Secretary.

Election Results

Count of ballots on December 15th resulted as follows:

President, Prof. H. H. Chapman, Yale School of Forestry, New Haven, Conn.; *Vice-President,* Earle H. Clapp, U. S. Forest Service, Washington, D. C.; *Council Members,* F. W. Besley, Maryland State Forest Service, Baltimore, Md.; Emanuel Fritz, University of California, Berkeley, California; Ward Shepard, Indian Forest Service, Washington, D. C.; S. N. Spring, N. Y. State College of Forestry, Syracuse, N. Y.

The vote on the proposed amendment to Article 3, Section 5, was 726 yes and 56 no. Article 3, Section 5, now reads, "Fellows shall be foresters of outstanding achievement as leaders in responsible directive or distinctive individual work of a fruitful character. They shall be elected from the Senior Members, and shall be engaged in forestry work at the time of their election. The total number of Fellows shall be limited to one per cent of the total number of voting members, and not more than two Fellows shall be elected at any one time."

Article 4, Section 4, now reads, "Elections to the grade of Fellow shall be by

letter ballot of the Senior Members and Fellows, and shall be held at the same time as elections of officers and members of the Council. In each case a total vote of one-half of those eligible to vote, and an affirmative vote of three-fourths of those actually voting, shall be necessary to elect."

The vote on the second section, "Do you agree that it is unnecessary to submit biographical data with Fellow ballot?" was 488 yes and 327 no.

The results of this latter vote will serve to guide the Council in preparing new by-laws necessitated by this amendment to the Constitution.

The tellers were H. F. Round, Allegheny Section, L. S. Murphy, Washington Section and P. B. Lister, Southwestern Section.

PAUL G. REDINGTON,
Secretary-Treasurer.

INCREASE IN NOMINATIONS

Nominations received during the past three months presage a substantial increase in membership for 1934. Sections, forest schools and members are urged to keep up the good work. A tabulation of the lists of candidates published in the October, November, December and January issues of the JOURNAL, by sections and grades is shown in Table 1.

TABLE 1

NOMINATIONS PUBLISHED OCTOBER, NOVEMBER, DECEMBER AND JANUARY

Section	Junior members	Senior members	Honorary	Total
Allegheny	36			36
Appalachian	23			23
California	5	11		16
Central Rocky Mt.	12	5		17
Gulf States	7	4		11
Intermountain	—	—		—
Minnesota	9	2		11
New England	38	4		42
New York	36		1	37
Northern Rocky Mt.	1			1
North Pacific	3			3
Ohio Valley	15			15
Ozark		2		2
Southeastern	1	2		3
Southwestern	1			1
Washington		1		1
Wisconsin	4			4
Philippine Island	6			6
	197	31	1	229

PERSONALS

John D. Coffman, who for the past 5 years has been fire control expert in the Field Division of Forestry for the National Park Service with headquarters at Berkeley, California, has recently been appointed chief forester in charge of the Branch of Forestry in the newly organized Office of National Parks, Buildings and Reservations in the Department of Interior.

SECTION NEWS

California

The annual meeting of the California Section was held in the Pacific Gas and Electric Company Auditorium, San Francisco, California, on December 18. The program was as follows:

Theme: "Social Aspects of Forests and Forestry."

1. Modern Social Trends and Relation to Forestry—Walter V. Woehlke, Author, formerly Managing Editor, *Sunset Magazine,* Los Angeles, California.

2. The Forester's Part in Developing the Social Value of Forests—Dr. E. P. Meinecke, Principal Forest Pathologist, San Francisco, California. Discussion by Chester B. Morse, De Witt Nelson, George M. Gowen, Francis Cuttle, Laurence Merriam, Hubert Person, William Mendenhall, Luther Gordon, Charles Dunwoody, Newton B. Drury and E. F. T. Wohlenberg.

3. The Place of Forestry in Land Use Planning—C. B. Hutchison, Dean, College of Agriculture, University of California. Discussion by Arnold Weber, M. A. Benedict, Hubert Person and W. G. Durbin.

4. The Part of Public Service in a Planned Economy—Dr. Carleton Ball, Bureau of Public Administration, University of California. Discussion by Chester B. Morse, Swift Berry, Prof. Walter Mulford, S. R. Black, M. A. Benedict and W. G. Durbin.

Society Affairs. Open Forum. Banquet, Roof Garden, Clift Hotel.

Central Rocky Mountain

On the evening of November 21 a dinner meeting of this section was held in Denver. The meeting was attended by 14 members and 2 guests. A paper by Forest Supervisor Theodore Krueger of the Black Hills National Forest entitled "Practices and Problems in the Disposal of Brush Resulting from Thinnings in Ponderosa Pine in the Black Hills National Forest" was read by Chairman Morrill. The paper was very interesting and instructive and stimulated considerable discussion.

Minnesota

A business meeting of this section was held in the Men's Union on the Agricultural Campus on November 16. A general summary of the previous meetings was read and brief reports were given by the secretary-treasurer and the membership committee. The following officers were elected to serve for 1934: L. W. Rees, *Chairman,* Division of Forestry, University Farm; S. R. Gevorkiantz, *Secretary-Treasurer,* Lake States Forest Experiment Station, University Farm, St. Paul, Minn.

After the business meeting, Mr. Grover Conzet, State Forester, led a lively discussion on conservation measures of the lumber code.

New York

R. S. Hosmer, as President of the Yale Forest School Alumni Association, attended a meeting of the Council of that body in New Haven, Conn., on December 1 and 2, 1933, where conferences were held with the several members of the staff of the Yale School of Forestry and plans made for the annual meeting of the Association, to be held on February 22, 1934.

A. B. Recknagel attended the October Conservation Conference in Washington, under Article X of the Lumber Code, as

representing the forest industries and, specifically, the Northeastern Lumber Manufacturers' Association. At the regional conference which followed in New York City on December 5, he presented to the timberland owners and operators of the Northeastern Division the proposals resulting from the Washington Conference. A committee was appointed to draft the final statement of the action which the Northeastern Division will take to conform to the requirements of the Code. On this committee Recknagel is serving as Secretary.

Elections to Membership

The following men have been elected to the grade of Junior Membership:

ALLEGHENY SCCTION

Adema, Howard
Cheston, Charles E.
Clapp, Robert T.
Hetzel, John E.
Palmer, Spencer H.
Shontz, J. Leslie
Watson, Earle B.

APPALACHIAN SECTION

Adams, Rellie W.
Brooks, Norman E.
Brown, Max T.
Davenport, Charles C.
Grumbine, Arthur A.
Henze, Karl D.
Hill, Hamilton D.
Medesy, William A.
Rasnake, James H.
Slocum, George K.
Thurmond, A. Kenneth, Jr.
Tuthill, Frank F.
Ventulett, David P.
Williams, Robert D.

CENTRAL ROCKY MOUNTAIN SECTION

Davis, Wilfred S.
Ericson, Earl E.
Johnson, Ernest W.
Post, Urban J.
Weldon, Robert K.

GULF STATES

Babin, W. J.
Darwin, William N.
Herrick, Clinton S.
Hobgood, Edward C.
May, Jack Truett

MINNESOTA SECTION

Aamot, Arthur L.
Cann, John T.
Day, Maurice W.
Fox, Gordon D.
Frederickson, Franklin
Frisbie, George C.
Koski, Sulo O.
Tesaker, Arvid
Tofte, Albert L.

NEW ENGLAND SECTION

Abbiati, Ennio
Altpeter, L. Stanford
Bankus, John T.
Beard, Fred, Jr.
Bisson, Adolph
Breon, Theo F.
Brown, Robert S.
Bruce, Mason B.
Burk, Frederick C.
Chaplin, D. Reed
Christen, Harold E.
Christie, Aldis J.
Dickson, Thomas F.
Diehl, Richard B.
Elliott, Richard E.
Evans, John B.
Frost, Sherman L.
Howes, Evans C.
McCready, Alan A.
McNasser, Karl W.
Mitchell, Harold L.
Morton, Paul
O'Neil, John D.
Parr, Thad
Rumazza, O. Lawrence
Schultz, MacAlister A.
Stankiewicz, Mitchell J.
Thompson, Wilbur E.
Waldo, Henry C.
Walker, Edward H.
Yale, Allen R.

NEW YORK SECTION

Abella, Ceferino S.
Boutwell, Lewis S.
Campbell, David
Coyne, Leonard J.
Henry, Edward H.
Lutz, Russell J.
McKean, Herbert B.
Meade, Fayette M.
Oja, Oscar W.
Reynolds, Charles E.
Rich, J. Harry
Ryan, John J.
Sanford, Arthur R.
Smith, Waldo G.
Thompson, John W.
Weiss, Russell G.
Welch, Donald S.

NORTH PACIFIC SECTION

Brockman, C. Frank
Rogers, Nelson S.
Wakeman, William J.

NORTHERN ROCKY MOUNTAIN SECTION

Wellner, Charles A.

OHIO VALLEY SECTION

Soper, Clyde L.

SOUTHEASTERN SECTION

Howard, Harry

SOUTHWESTERN SECTION

Steirly, Charles C.
Thompson, Jerome

WISCONSIN SECTION

Brownell, John K.

PHILIPPINE ISLANDS

Achacoso, Isabelo
Laraya, Sixto
Oliveros, Severo
Ponce, Severo S.
Roque, Tonias N.
Tabat, Evaristo

Announcement of Candidates for Membership

The following names of candidates for membership are referred to Junior Members, Senior Members and Fellows for comment or protest. The list includes all nominations received since the publication of the list in the December Journal, without question as to eligibility. The names have not been passed upon by the Council. Important information regarding the qualifications of any candidate, which will enable the Council to take final action with a knowledge of essential facts, should be submitted to the undersigned before February 10, 1934. Statements on different men should be submitted on different sheets. Communications relating to candidates are considered by the Council as strictly confidential.

FOR ELECTION TO GRADE OF JUNIOR MEMBERSHIP

Name and Education	*Title and Address*	*Proposed by Section*
Ackerman, Philmore E. N. Y. State Ranger, 1927	Senior Forest Ranger, Allegheny For. Exp. Sta., Kane, Pa.	Allegheny
Agnew, Theo. W. Purdue, B.S.F., '31; M.S., '33.	Forestry Foreman, Camp 51-S, U. S. F. S., Henryville, Ind.	Ohio Valley
Aschenbach, Ernst F. Pa. State, B.S., '33.	Technical Foreman, Willoughby State Forest, West Burke, Vt.	New England
Ayers, Arthur W. Pa. State, B.S.F., '33.	Forester, C.C.C. Camp No. 125, Elimsport, Pa.	Allegheny
Barner, George W. N. C. State, B.S.F., '31.	Senior Camp Forester, C.C.C. Camp, Loganton, Pa.	Allegheny
Bernardini, Mario Univ. of Mich., B.S.F., '33.	Forester, C.C.C. Camp 656, Mountain, Wis.	Ohio Valley
Bietsch, Tom Pa. State, B.S.F., '08.	Chief Surveyor, Dept. of Forests and Waters, Harrisburg, Pa.	Allegheny
Boehm, Edward E. Univ. of Mont., 2 years.	Forest Ranger, Plumas N. F., Berry Creek, Calif.	California
Brandt, Ray W. Pa. State, B.S., 1933	Technical Foreman, E.C.W. Camp No. 51, Branchville, N. J.	Allegheny
Brender, Ernst V. Univ. of Mich, B.F., 1933	Technical Adm. Research, Appalachian For. Exp. Sta., Suches, Ga.	Appalachian
Bryan, Milton M. Pa. State, B.S.F., 1931	Cultural Foreman, Cherokee N.F., Suches, Ga.	Allegheny
Buck, John M. Oregon State, 3¾ years, Forestry Course.	Asst. Ranger, Mendocino N. F., Upper Lake, Calif.	California
Buhrman, William T. N. C. State, B.S.F., '31.	Camp Forester, Camp 70, Waynesboro, Pa.	Allegheny
Bunnell, Ralph G. Conn. State, 2-year course in Agriculture, '22.	Forest Ranger, Natchaug State Forest, Eastford, Conn.	New England
Davenport, Oscar M. Pa. State, B.F., '33.	Instructor in Forestry, Pa. State, Mont Alto, Pa.	Allegheny
Dunn, M. R. Iowa State, B.S.F., 1933.	Forestry Foreman, C.C.C. Camp 1463, Wartburg, Tenn.	Minnesota
Eaton, James L. Univ. of Ga., B.S.F.	Cultural Foreman, Unaka N.F., Viola, Tenn.	Appalachian
Fegel, Arthur C. N. Y. State, B.S.F., '33.	Graduate work at N. Y. State, working for M. F., Syracuse, N. Y.	New York
Fry, George W. Pa. State, B.S.F., '33.	Cultural Foreman, Laurel Camp, Monongahela N. F., Glady, W. Va.	Allegheny
Fuerchtenicht-Boening, Rudolph 4 years Peoples School, 2 years Forester-School, Schoenebeck, Germany.	Forestry Foreman, E. C. W. Camp 51-S, Henryville, Ind.	Ohio Valley
Gerfin, Robert M. Pa. State, B.S.F., '32.	Asst. Forester, C.C.C. Camp S-60, Swanton, Md.	Allegheny

Name and Education	*Title and Address*	*Proposed by Section*
Iafer, Alvin B. N. C. State, B.S.F., 1933	Cultural Foreman, C.C.C. Camp F-4, Marion, N. C.	Appalachian
ohnson, William H. Pa. State, B.S.F., 1933	Technical Asst. E. C. W., Camp No. 130, Pa.	Allegheny
Iench, Maynard H. Pa. State, B.S.F., '31.	Project Supt., E. C. W. Camp No. 110, East Waterford, Pa.	Allegheny
endig, John D. Pa. State, B.S., '33	Forestry Foreman, Wilgus State Forest Camp, Bellows Falls, Vt.	New England
Iatthews, William P. La. State, B.S.F., 1933	Project Supt., U.S.F.S., Haleyville, Ala.	Appalachian
Iuller, John C. Pa. State, B.S.F., '23.	Forester, Dept. of Forests and Waters, Trout Run, Pa.	Allegheny
Ielson, Alf Z. Univ. of Minn., B.S., 1931; Yale, M.F., '33.	Forest Technician, U. S. F. S., Glendora, Calif.	California
Orth, Grover C., Jr. Pa. State, B.S.F., 1932	Asst. Supt., C.C.C. Camp S-53, Flintstone, Md.	Allegheny
erkins, Neil L. Univ. of Calif., 2 years Forestry Course.	Senior Forest Ranger, Stanislaus N. F., Groveland, Calif.	California
iersol, James L. N. Y. State, B.S.F., '33.	Cultural Foreman, Nantahala, N. F.	New York
yle, E. Clyde Pa. State, B.S.F., '26.	Dist. Forester, Delaware State Forest Dist., Stroudsburg, Pa.	Allegheny
obinson, Floridon E. Pa. State, B.S.F., 1933	Camp Forester, C.C.C. Camp 60, Petersburg, Pa.	Allegheny
obinson, Seward O. N. Y. State, B.S., '29.	Foreman, C.C.C. Camp No. 59, Lebanon State Park, Burlington County, N. J.	New York
oss, Charles R. Univ. of Wash., M.S.F., 1932	Cultural Foreman, Pisgah N.F., Hot Springs, N. C.	Appalachian
undgren, John A. Univ. of Minn., B.S.F., 1933	Technical Foreman, C.C.C. Camp, Robinson Forest, Noble, Ky.	Minnesota
aunders, Ralph C. Pa. State, B.S.F., '33.	Foreman, C.C.C. Camp No. 8, Port Elizabeth, N. J.	Allegheny
chaeffer, George K. N. C. State, B.S.F., '32.	Project Supt., C.C.C. Camp F-3, Old Fort, N. C.	Appalachian
echrist, William C. Pa. State, B.S.F., 1932	Instructor in Forestry, Pa. State, Mont Alto, Pa.	Allegheny
weitzer, Mark D. Pa. State, B.S.F., '26; Harvard, M.L.A., '29.	Forester, C.C.C. Camp No. 130, Sinnamahoning, Pa.	Allegheny
ucker, David M. Univ. of Mont., B.S.F.	Adm. Guard, San Bernardino N. F., Fresno, Calif.	California

FOR ELECTION TO GRADE OF SENIOR MEMBERSHIP

acobs, Allen W. Univ. of Calif., B.S.F., '23; M.S., '24 (Junior Member 1925).	Asst. Prof., San Jose State Teachers College, San Jose, Calif.	California
orgny, Bruce Tekniska Skolan, Sweden, 2 years; eather River Training School. (Junior Member 1928)	Dist. Forest Ranger, Roosevelt N. F., Logcabin, Colo.	Central Rocky Mt.

C. F. Korstian,
Member of Council in Charge of Admissions.

SOCIETY OFFICERS

Officers and Members of Council

President, H. H. Chapman, Yale School of Forestry, New Haven, Conn.
Vice-President, Earle H. Clapp, Forest Service, Washington, D. C.

Council

The Council consists of the above officers and the following members:

	Term expires
C. M. Granger	Dec. 31, 1935
F. W. Besley	Dec. 31, 1937
Emanuel Fritz	Dec. 31, 1937
Ward Shepard	Dec. 31, 1937
S. N. Spring	Dec. 31, 1937
E. L. Demmon	Dec. 31, 1935
A. F. Hawes	Dec. 31, 1935
C. F. Korstian	Dec. 31, 1935
Hugo Winkenwerder	Dec. 31, 1935

Member in Charge of Admissions

C. F. Korstian

Executive Offices

810 Hill Bldg., Washington, D. C.
Franklin W. Reed, *Executive Secretary*

Section Officers

Allegheny

K. E. Pfeiffer, Chairman, Asst. State Forester, 1411 Fidelity Bldg., Balto., Md.
W. S. Taber, Vice-Chairman, State Forester, Dover, Del.
H. F. Round, Secretary, Forester's Office, Pa. R. R. Co., Philadelphia, Pa.

Appalachian

C. F. Evans, Chairman, 223 Federal Bldg., Asheville, N. C.
F. H. Claridge, Vice-Chairman, Dept. of Conservation and Development, Raleigh, N. C.
I. H. Sims, Secretary, 223 Federal Bldg., Asheville, N. C.

California

George H. Cecil, Chairman, Chamber of Commerce, Los Angeles, Calif.
Jay H. Price, Vice-Chairman, U. S. Forest Service, San Francisco, Calif.
Russell Beeson, Secretary, U. S. Forest Service, San Francisco, Calif.

Central Rocky Mountain

W. J. Morrill, Chairman, 617 Remington St., Ft. Collins, Colo.
Wm. R. Kreutzer, Vice-Chairman, Box 567, U. S. Forest Service, Ft. Collins, Colo.
H. D. Cochran, Vice-Chairman, (Denver) U. S. Forest Service, Denver, Colo.
C. L. Van Giesen, Secretary-Treasurer, U. S. Forest Service, Ft. Collins, Colo.

Gulf States

P. M. Garrison, Vice-Chairman, Bogalusa, La.
Robert Moore, Secretary, University Station, Baton Rouge, La.

Intermountain

Dana Parkinson, Chairman, U. S. Forest Service, Ogden, Utah.
Charles N. Genoux, Univ. of Idaho, Southern Branch, Pocatello, Idaho.
H. N. Shank, Secretary, U. S. Forest Service, Ogden, Utah.

Minnesota

L. W. Rees, Chairman, Div. of Forestry, University Farm, St. Paul, Minn.
S. R. Gevorkiantz, Secretary-Treasurer, Lake States Forest Exp. Sta., Univ. Farm, St. Paul, Minn.

New England

A. C. Cline, Chairman, Harvard Forest, Petersham, Mass.
H. J. MacAloney, Secretary, Northeastern Forest Exp. Sta., 335 Prospect St., New Haven, Conn.

New York

H. P. Brown, Chairman, N. Y. State College of Forestry, Syracuse, N. Y.
H. C. Belyea, Secretary, N. Y. State College of Forestry, Syracuse, N. Y.

Northern Rocky Mountain

L. F. Watts, Chairman, U. S. Forest Service, Missoula, Mont.
J. E. Ryan, Vice-Chairman, U. S. Forest Service, Newport, Wash.
John B. Taylor, Secretary, U. S. Forest Service, Missoula, Mont.

North Pacific

H. J. Andrews, Chairman, U. S. Forest Service, Portland, Ore.
S. A. Wilson, Secretary-Treasurer, Pac. N .W. Forest Exp. Sta., U. S. Court House, Portland, Ore.
Vice-Chairman, Oregon: S. V. Fullaway, 510 Yeon Bldg., Portland, Ore.
Vice-Chairman, Washington: C. S. Chapman, c/o Weyerhaeuser Timber Co., Tacoma, Wash.
Vice-Chairman, British Columbia: R. C. St. Clair, District Forester, Vancouver, Can.
Vice-Chairman, Hawaii: C. S. Judd, 1828 Vancouver Highway, Honolulu, Hawaii.
Vice-Chairman, Alaska: B. F. Heintzleman, U. S. Forest Service, Juneau, Alaska.

Ohio Valley

Stanley, S. Locke, 121 State Capitol, Springfield, Ill.
T. E. Shaw, Secretary-Treasurer, Purdue University, Lafayette, Ind.

Ozark

Glen Durrell, Chairman, Okla. Forest Service, Broken Bow, Okla.
Wilson Martin, Vice-Chairman, Highland Rim Office, Dickson, Tenn.
Charles A. Gillett, Secretary, 1923 N. Tyler St., Little Rock, Ark.

Southeastern

R. E. Benedict, Chairman, Brunswick, Ga.
H. M. Sebring, Vice-Chairman, Asst. State Forester, Atlanta, Ga.
C. H. Coulter, Secretary-Treasurer, Box 411, Lake City, Fla.

Southwestern

Frederic Winn, Chairman, 1401 Rincon Road, Tucson, Ariz.
William H. Zeh, Vice-Chairman, 606 N. 12th St., Albuquerque, N. M.
Bert R. Lexen, Secretary-Treasurer, S. W. For. and Range Exp. Sta., Univ. of Ariz., Tucson, Ariz.

Washington

J. P. Kinney, Chairman, Indian Office, Dept. of Interior, Washington, D. C.
Alfred E. Fivaz, Vice-Chairman, Bureau Plant Industry, Washington, D. C.
William A. Dayton, Secretary, U. S. Forest Service, Washington, D. C.

Wisconsin

Crosby A. Hoar, Chairman, U. S. Forest Service, Milwaukee, Wis.
William L. Barker, Jr., Secretary, U. S. Forest Service, Milwaukee, Wis.

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"When slung on the back, it at once fits into position without knocks or hardness to any part of the body. There is no leakage to wet the back. With the RANGER SPECIAL one can keep perfectly dry no matter how long it is carried."

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1. Made of seamless fabric (not metal)—it fits wearer's back like a cushion—no chafing; no discomfort.
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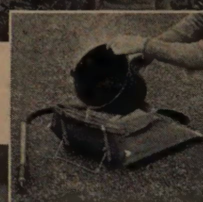
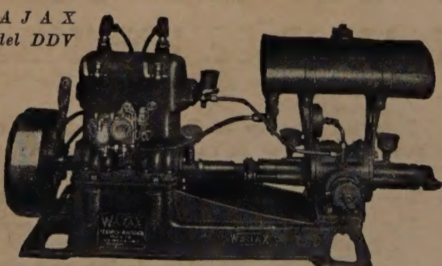


Fills quickly. Patented closing lock guarantees a dry back at all times.

Rolls up in compact space.

FENWICK-REDDAWAY MFG. CO.

WAJAX Model DDV



The successful performance of the WAJAX Forest Fire Pump for long periods of time and under severe conditions, is ample evidence of **Power, Capacity, Durability and Simplicity!**

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